EXHIBIT A

Evaluation of the Sources, Fate, and Transport of Polychlorinated Biphenyls (PCBs) and Other Substances in the Spokane River Watershed

Prepared by

Kurt Herman, M.Eng., P.G.

Prepared for
Monsanto Company, Solutia, Inc., and Pharmacia LLC

November 14, 2019

GRADIENT
www.gradientcorp.com
20 University Road
Cambridge, MA 02138
617-395-5000

Table of Contents

Page

List of Tables

All Tables are embedded in the text.

List of Charts

All Charts are embedded in the text.

List of Figures

All Figures are appended at the end of the report.

Abbreviations

AO	Administrative Order
BOD	Biochemical Oxygen Demand
CBOD	Carbonaceous Biochemical Oxygen Demand
CSO	Combined Sewer Overflow
DDT	Dichlorodiphenyltrichloroethane
DO	Dissolved Oxygen
DPRK	Democratic People's Republic of Korea
E&E	Ecology and Environment, Inc.
E-waste	Electronic Waste
FIN	Fishmeal Information Network
GC	Gas Chromatography
GE	General Electric
HSPF	Hydrological Simulation Program – FORTRAN
I&I	Infiltration and Injection
ICWP	Integrated Clean Water Plan
IEP	Inland Empire Paper Company
ITF	Interdepartmental Task Force on PCBs
IUPAC	International Union of Pure and Applied Chemistry
METI	Ministry of Economy, Trade and Industry
MIT	Massachusetts Institute of Technology
MS4	Municipal Separated Storm Sewer System
NIEHS	National Institute of Environmental Health Sciences
NOV	Notice of Violation
NPDES	National Pollutant Discharge Elimination System
PBDE	Polybrominated Diphenyl Ether
PCB	Polychlorinated Biphenyl
PCDD	Polychlorinated Dibenzo-p-dioxin
PCDF	Polychlorinated Dibenzofuran
PCT	Polychlorinated Terphenyl
PHTS	Panel on Hazardous Trace Substances
ppb	Parts Per Billion
ppm	Parts Per Million
ppq	Parts Per Quadrillion
ppt	Parts Per Trillion
Riverside WWTP	Riverside Park Water Reclamation Facility
SIU	Significant Industrial User
SJA	Spokane Junkyard and Associated Properties Superfund Site
SMC	Spokane Metals Company
SVRP	Spokane Valley-Rathdrum Prairie
SWWM	Spokane Wastewater Management Department
Task Force	Spokane River Regional Toxics Task Force
TMDL	Total Maximum Daily Load
TSCA	Toxic Substances Control Act

TSS	Total Suspended Solids
US EPA	United States Environmental Protection Agency
US FDA	United States Food and Drug Administration
USDA	United States Department of Agriculture
USGS	United States Geological Survey
USSR	Union of Soviet Socialist Republics
WDFW	Washington State Department of Fish and Wildlife
WADOH	Washington Department of Health
WA Ecology	Washington State Department of Ecology
ww	Wet Weight
WWTP	Wastewater Treatment Plant

Introduction

Qualifications

I am a licensed Professional Geologist in Washington State, and I have earned a Master of Engineering degree in environmental engineering from the Massachusetts Institute of Technology (MIT) (Attachment 1). I specialize in evaluating the ways chemicals are released into the environment and their movement and behavior in the environment after they are released. This specialty field is commonly referred to as "chemical fate and transport." During my 20+ years of academic and professional experience in the environmental field, I have worked on many complex urban water bodies and watersheds,[1] including in the Pacific Northwest. My work routinely includes evaluating the sources, fate, and transport of chemicals using various scientific techniques, such as evaluating the spatial distribution of chemicals in different environmental media,[2] analyzing chemical mass loading, and performing forensic chemistry analyses. I have published scientific papers and lectured at MIT's environmental engineering graduate school on these topics. In addition, I have testified about chemical fate and transport and about polychlorinated biphenyls (PCBs). Attachment 1 provides further information about my educational and professional experience, including publications within the last 10 years and testimony experience. Gradient is currently compensated at the rate of $390 per hour for my work on this case, including for the preparation of this report and any deposition or trial testimony.

Methodology

In order to reach my conclusions, I performed a comprehensive analysis of the Spokane River and the Spokane River watershed, of sources of chemicals within the watershed, and of the City of Spokane's sewer system. Specifically, I reviewed prior studies of the Spokane River issued by public agencies, such as the United States Environmental Protection Agency (US EPA), the United States Geological Survey (USGS), and the Washington State Department of Ecology (WA Ecology); the Spokane River Regional Toxics Task Force (referred to as the "Task Force" herein); and the City of Spokane, including studies that evaluated sewage, phosphorus, metals, dioxin, and PCBs in the river. I visited the Spokane River multiple times and inspected the City's sewer system and wastewater treatment plant (WWTP). Using multiple public databases, I identified sites where PCBs were used and sites where PCBs were released to the environment within the Spokane River watershed. I compiled and analyzed all of the publicly available, relevant data that I was able to acquire pertaining to the river, the City's sewer system, and sites in the Spokane River watershed in order to understand:

- The amount and distribution of chemicals in different geographical areas and in different environmental media within the Spokane River watershed;
- The mechanisms by which chemicals including PCBs are/were released from sources into the watershed; and

---

[1] A "watershed" is a land area that channels rainfall and snowmelt to rivers and streams and eventually to discharge points, such as the ocean.

[2] The term "environmental media" refers to different components of the natural environment, including air, surface water, groundwater, soil, and biota (animal and plant life).

- The pathways by which chemicals including PCBs are transported from these sources to the Spokane River.

I also researched the prevalence of "byproduct"[3] PCBs that US EPA, WA Ecology, and the City of Spokane currently allow to be used in products, as well as the production, use, and global decline of legacy "product" PCBs over time.

Conclusions

Based upon my qualifications, my review of published studies and documents, and my analyses of the data, I have reached the following conclusions. I also indicate below which report section corresponds to which conclusion.

1. Spokane River water quality has been significantly impacted by sewage, phosphorous, and metals (Section 1).
2. The levels of PCBs in the Spokane River are below applicable regulatory levels (Section 4).
3. PCBs in the Spokane River that have been confirmed by data are predominantly byproduct PCBs and fire safety PCBs (Section 6).
4. Spokane River fish contain PCBs from byproduct PCB and international sources (Section 6).
5. PCB levels in the Spokane River have declined and are expected to continue to decline (Section 4).
6. The City's actions demonstrate that PCBs in the river are not a problem (Section 5).
7. The levels of PCBs discharged in municipal separated storm sewer system (MS4) stormwater do not cause exceedances of water quality criteria in the river. The MS4 permit does not even mention PCBs, and the MS4 upgrade projects were required for constituents other than PCBs (Section 5).

[3] Byproduct PCBs are PCBs that are produced inadvertently during other industrial or chemical processes. They are sometimes referred to at "inadvertently generated" PCBs.

1 Spokane River Watershed Setting

The geography and hydrology of the Spokane River watershed play an important role in the fate and transport of chemicals within the river. In the following sections (Sections 1.1 and 1.2), I provide a basic overview of the river and watershed characteristics that are relevant to the fate and transport of chemicals within the river. In Section 1.3, I discuss the historical and present-day conditions in the river, including the role of the City's discharges of untreated raw sewage and the impact caused by the loading of heavy metals from the Spokane River watershed. Section 1.4 provides a short overview of the current City of Spokane sewer systems.

1.1 Geographic Description

The Spokane River flows from east to west for 112 miles, from Lake Coeur d'Alene in Idaho to its confluence with the Columbia River in central Washington (Figure 1). The watershed encompasses approximately 6,000 square miles in both Washington and Idaho (LimnoTech, 2016a). The majority of the watershed is low mountains and undeveloped land, including forested land, rangeland, and agricultural land (GeoEngineers, Inc. *et al*., 2011), although the river itself flows through the cities of Coeur d'Alene, Idaho; Post Falls, Idaho; Spokane Valley, Washington; and Spokane, Washington, as well as several smaller municipalities. The City of Spokane abuts approximately 18 miles of the Spokane River. Mining activities in the Coeur d'Alene region of Idaho began in the 1800s and continue through the present, and these activities contribute to the presence of metals in the Spokane River (Balistrieri, 1998).

The climate in the region of eastern Washington and the Lake Coeur d'Alene region of Idaho is semi-arid to temperate (Sankarasubramanian and Vogel, 2003), averaging 18 inches of precipitation per year in the City of Spokane (WA Ecology, 2011a) and ranging from approximately 5 inches per year west of Spokane to more than 50 inches per year in the mountains east of Lake Coeur d'Alene (GeoEngineers, Inc. *et al*., 2011). Precipitation is lowest in August and highest during the spring months (GeoEngineers, Inc. *et al*., 2011).

1.2 River Characteristics

The river characteristics are relevant to my opinions because they impact the fate and transport of substances within the river. The Spokane River is a fast-flowing river in Idaho and Eastern Washington that falls a cumulative 700 feet over the 112-mile distance between Lake Coeur d'Alene and the Columbia River. Along the way, the river flows past numerous municipalities that discharge wastewater and stormwater, past industrial waste dischargers and agricultural regions and through seven dams (see Figure 1). These dams have fundamentally altered the Spokane River from its natural state and contribute to its dissolved oxygen (DO) impairment (see Section 1.3). Each dam creates an impoundment of deeper, slower-moving water behind it, with the largest impoundment being Long Lake behind the Lake Spokane Dam. Sediments settle out of the water column in Lake Coeur d'Alene in Idaho; the reduced sediment supply, combined with the high water velocity reaches in Washington State mean that there is a lack of fine sediment deposition in the portion of the river within Washington State (WA Ecology, 2011a). The riverbed along these reaches is typically covered with larger rocks, stones, and gravel. Fine sediment deposition tends to occur only in discrete areas, including behind the dams (WA Ecology, 2011a). The lack of fine sediment deposition and

the high velocities in the system mean that chemicals that are discharged to the river tend to be rapidly flushed out of the river rather than remain in the system.

Seasonal variation in rainfall and spring snowmelt causes high flows in spring and large seasonal fluctuations in flow rates in the Spokane River. Between the average high flow in spring and the low flow in late summer,[4] flow in the river varies by approximately a factor of 10 (WA Ecology, 2011a) (see Chart 1.1). These high spring flows in the river and the lack of depositional areas mean that fine sediments and any chemicals that are bound to them are generally flushed from the river.

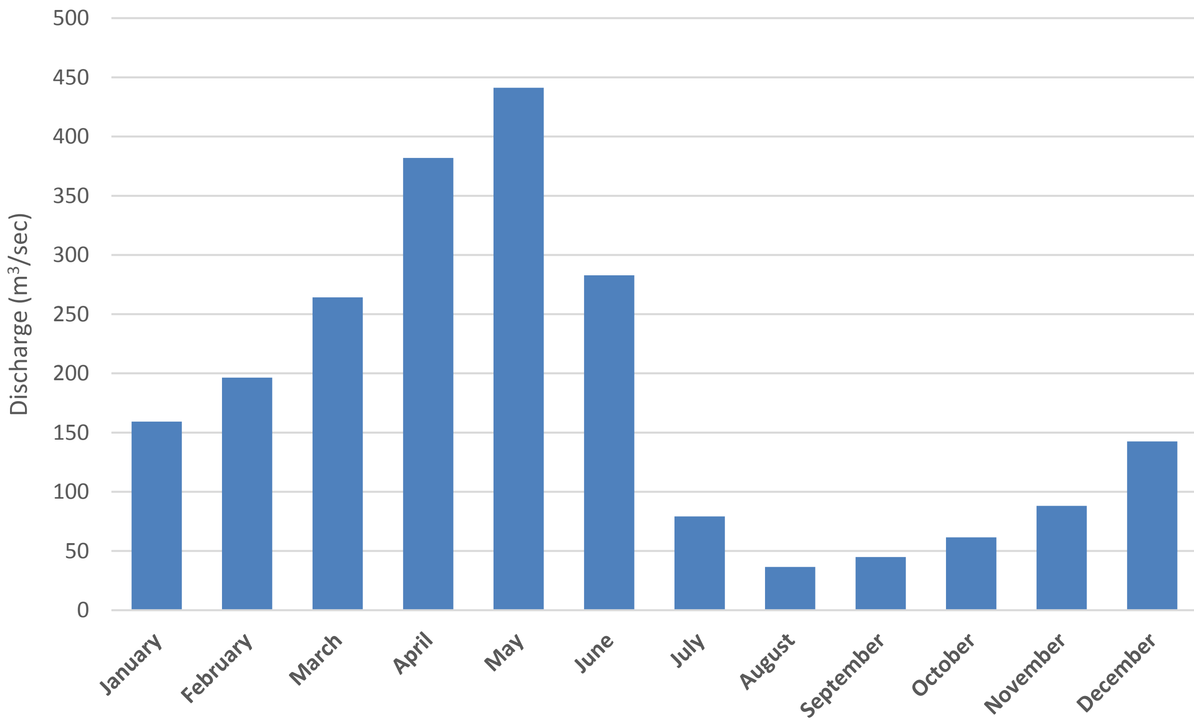


Chart 1.1 Long-term Spokane River Monthly Flow Rates (Arithmetic Mean) at "Spokane River at Spokane" Gage (Monroe Street). Data Source: WA Ecology (2011a).

Major tributaries along the Spokane River in Washington State include Hangman Creek (also known as Latah Creek) and the Little Spokane River.

A portion of the flow in the Spokane River comes from groundwater discharge from the Spokane Valley-Rathdrum Prairie (SVRP) aquifer. The SVRP aquifer is highly transmissive[5] (2,600-6,000 ft/day) and mainly composed of coarse deposits ranging from gravel to boulders (Kahle and Bartilino, 2007). The highly transmissive nature of the aquifer combined with the presence of industrial sites adjacent to the river (Section 6) with chemicals such as petroleum hydrocarbons (fuels and oils such as mineral oil) present in their groundwater means that groundwater loading is a potential pathway for chemicals and chemicals dissolved in petroleum hydrocarbons to enter the river.

[4] The arithmetic mean of flow in May is approximately 450 m^3/s (cubic meters per second) at Monroe Street. The arithmetic mean of flow in August at Monroe Street is approximately 38 m^3/s (WA Ecology, 2011a).
[5] The "transmissivity" of an aquifer is its ability to convey water, and is the product of the aquifer's hydraulic conductivity and its thickness.

1.3 River Conditions: Past and Present

1.3.1 The City of Spokane repeatedly ignored orders to prevent raw sewage from entering the Spokane River.

Since the establishment of its sewer system in 1888, and despite an 1885 City ordinance forbidding the dumping of excrement or garbage into the river, the City of Spokane has discharged raw sewage into the Spokane River now for more than 130 years, despite being ordered numerous times by regulatory authorities since 1909 to cease discharges. The City's 30(b)6 fact witness, Lars Hendron, stated that the City of Spokane recognized water quality problems in the river as early as 1885 (Hendron, 2019, p. 26). In 1909, the Washington Department of Health (WADOH) ordered the City to stop discharging sewage into the river (Bovay Northwest, Inc., 1994). The City did not comply with this order (Hendron, 2019, p. 31), and raw sewage was still visible in the river in the 1920s (Bovay Northwest, Inc., 1994). In 1929, WADOH again ordered the City to stop discharging sewage into the river; however, the City did not comply with this order and sewage discharges continued (Bovay Northwest, Inc., 1994). WADOH considered the raw sewage in the river to be a nuisance, and the City's fact witness agreed with this characterization (Hendron, 2019, p. 49).

Consultants to the City Engineer recommended that the City of Spokane build a wastewater treatment plant (WWTP) in 1933, but the City did not build a WWTP (*i.e.*, the Riverside Park Water Reclamation Facility [Riverside WWTP]) until 1958 (Pearce, Greeley & Hansen, 1933; Esvelt & Saxton and Bovay Engineers, Inc., 1972; Hendron, 2019, pp. 34-35). The City's fact witness stated that the river's water quality most likely deteriorated between 1933 and 1958 (Hendron, 2019, p. 36). The capacity of the City's WWTP was inadequate from the start. During wet weather, untreated wastewater was discharged directly to the river, because the plant could not handle the amount of flow (Bovay Northwest, Inc., 1994; Hendron, 2019, pp. 56-57). At the time the plant began operating, it could only handle 55% of the City's wastewater, with 45% discharged untreated to the river (Reisdorph and Wilson, 1963).

In addition to inadequate capacity, this first treatment plant included only primary treatment, *i.e.*, solids removal *via* a clarifier (Bovay Northwest, Inc., 1994). Digesters were not added to the treatment plant until 1962 (Bovay Northwest, Inc., 1994). According to a 1957 survey, the majority (61.8%) of other treatment plants in the US at this time included secondary treatment (US Dept. of Health, Education, and Welfare, 1958), which means that at the time the City of Spokane started constructing its first treatment plant, most other municipalities already had secondary treatment in place. This is in addition to the plant being undersized (see above). For example, just upriver, the City of Coeur d'Alene, Idaho, had secondary treatment technology at its WWTP in 1939, nearly 20 years before Spokane even installed primary treatment (Spokane Daily Chronicle, 1938; US Dept. of the Interior, 1942). Secondary treatment was not added to the City of Spokane treatment plant until 1977, when Spokane was ordered to do so by the Washington State Department of Ecology (WA Ecology) (Esvelt & Saxton and Bovay Engineers, Inc., 1972; Patmont, 1987). The practice of discharging untreated human waste to the river in order to manage treatment plant capacity continues today through combined sewer overflow (CSO) discharges (WA Ecology, 2017d). In 1970, WA Ecology issued a regulation requiring that the sewage discharges, which violated state water quality standards, be controlled (WA Ecology, 1972). The City of Spokane failed to adhere to the timeline set forth by WA Ecology and was issued a Notice of Violation (NOV) in 1972 (WA Ecology, 1972). In 1974, the first National Pollutant Discharge Elimination System (NPDES) permit for the City's sewer system was issued by Washington State, and this permit set a deadline in 1977 for the cessation of all CSOs (US EPA Region X, 1979). This deadline was modified and extended several times, but decades later, the City has still not fixed the problem nor met the deadlines (Hendron, 2019, p. 273).

In 1985, Washington State required cities to create and submit CSO reduction plans by 1988 (Bovay Northwest, Inc., 1994). The City of Spokane failed to meet this deadline and did not submit its CSO reduction plan to WA Ecology until 1994 (Bovay Northwest, Inc., 1994). However, the Spokane City Council did not act on the CSO reduction plan right away – 5 years passed before the City Council finally approved the plan, in December 1999 (Arnold, 2000). The plan set a deadline for controlling all CSO outfalls by December 31, 2017 (Bovay Northwest, Inc., 1994). Around this time in the 1990s, the City was aware of sampling done by Dr. Soltero of Eastern Washington University that did not detect polychlorinated biphenyls (PCBs) in the river (Hendron, 2019, p. 160). Similarly, in 1999, the City released its Wastewater Facilities Report, which makes no mention of PCBs (Hendron, 2019, p. 190). In June 2017, WA Ecology issued an Administrative Order (AO) requiring that the City of Spokane comply with state pollution requirements, because the City was not on track to meet the December 31, 2017, deadline for controlling CSO outfalls set in the City's NPDES permit (WA Ecology, 2017d). The City was ordered to provide dates for when each CSO outfall would be controlled. The City admitted, in its response to WA Ecology, that many CSOs were still uncontrolled and still discharging raw sewage to the river (Simmons, 2017). The City also estimated at this time that all CSO outfalls would be controlled by December 31, 2019 (Simmons, 2017). The City's current NPDES permit for its CSO discharges and WWTP effluent discharges sets limits for constituents such as phosphorus, ammonia, and biochemical oxygen demand (BOD), but contains no PCB discharge requirements;[6] the only PCB-related stipulations are periodic monitoring and participation in the Spokane River Regional Toxics Task Force (referred to as the "Task Force" herein) (Hendron, 2019, p. 274).

1.3.2 Other non-PCB substances are present in the river at levels that exceed government screening levels.

In addition to the presence of raw sewage in the river due to the continued sewer discharges by the City of Spokane, there are a large number of other substances and water quality conditions in the river that do not meet screening levels established by government agencies. These substances and water quality conditions include the presence of dioxin, bacteria, dissolved gas, phosphorus, and metals (such as lead, cadmium, and zinc); low DO; pH; excessive temperature and turbidity; as well as the presence of invasive exotic species. In fact, the United States Geological Survey (USGS) states that from 2009 to 2013, approximately 700,000 lbs of zinc, 36,000 lbs of lead, and 3,000 lbs of cadmium were discharged annually from Lake Coeur d'Alene into the Spokane River (Clark and Mebane, 2014). These annual average discharges of heavy metals into the Spokane River have not significantly declined over time. The 2014 Integrated Clean Water Plan (ICWP) estimated that the City of Spokane itself discharged thousands of pounds of phosphorus to the river each year from the City's municipal separated storm sewer system (MS4) and CSOs (CH2M HILL, 2014). In addition to these specific chemicals, the City is responsible for discharging millions of gallons of untreated wastewater and raw sewage into the river every year (Spokane, Washington. 1999-2017).

High levels of phosphorus in the river cause algae growth and decay, which results in low DO in the water column (GeoEngineers, Inc. *et al*., 2011; CH2M HILL, 2014). The presence of phosphorus in the river and the continued discharges of phosphorus are one of the primary drivers of upgrades to the City sewer system and WWTP (CH2M HILL, 2014). Phosphorous sources include municipal stormwater and WWTP effluent, as well as a range of non-point sources, including fertilizer, livestock and pet waste, and failing septic systems (WA Ecology, 2017e; GeoEngineers, Inc. *et al*., 2011). According to WA Ecology (2017e), "[a]lgae blooms and low dissolved oxygen levels in the lower depths of Lake Spokane (Long Lake) have existed for decades."

[6] Similarly, the NPDES permit for the City's MS4 does not contain PCB discharge requirements (WA Ecology, 2011b, 2016b).

The presence of metals in the Spokane River is due to present and historical mining activity upriver in Idaho and the presence of other industry along the river corridor. Mining activities began in the Coeur d'Alene region in the 1800s and continue through the present (Balistrieri, 1998). These mining activities, including dozens of mines in the Coeur d'Alene region of Idaho alone, resulted in the presence of lead, zinc, cadmium, and arsenic in Lake Coeur d'Alene, which drains into the Spokane River (Balistrieri, 1998). Between 1883 and 1987, over 130 million tons of lead, zinc, and silver-sulfide ores were mined from the Coeur d'Alene mining district (Clark and Mebane, 2014). According to USGS, these activities "altered the water quality, aquatic biological, and hydrologic conditions in the Spokane and Coeur d'Alene River Basins" (Clark and Mebane, 2014). WA Ecology (2012) similarly concluded that "[t]he primary source of… metals loading to the Spokane River is from the Coeur d'Alene Basin Superfund Site in Idaho, a basin-wide legacy mining site." Despite some metals remediation conducted in the 1990s, metals are still found in the surface water, soils, sediment, and groundwater of the Spokane River watershed (Clark and Mebane, 2014).

In addition, Spokane River fish have elevated levels of polybrominated diphenyl ether (PBDE) (relative to nine other rivers and 10 lakes sampled for fish tissue in Washington State) (WA Ecology, 2012).

As a consequence of these discharges of numerous substances, there are total maximum daily loads (TMDLs) in place in the river for metals (zinc, lead, and cadmium) as well as for DO, which regulates the discharge of phosphorus, ammonia, and carbonaceous biochemical oxygen demand (CBOD) (Hendron, 2019, pp. 205-206). Additionally, many surface water bodies in the Spokane River watershed are included on the Clean Water Act Section 303(d) list of "impaired waters"[7] for the presence of these non-PCB substances (WA Ecology, 2014a; Figure 2).

[7] Section 303(d) of the Clean Water Act requires states to assemble a list of water bodies that do not meet the federal water quality standards. These water bodies are referred to as "impaired" by US EPA (2018a).

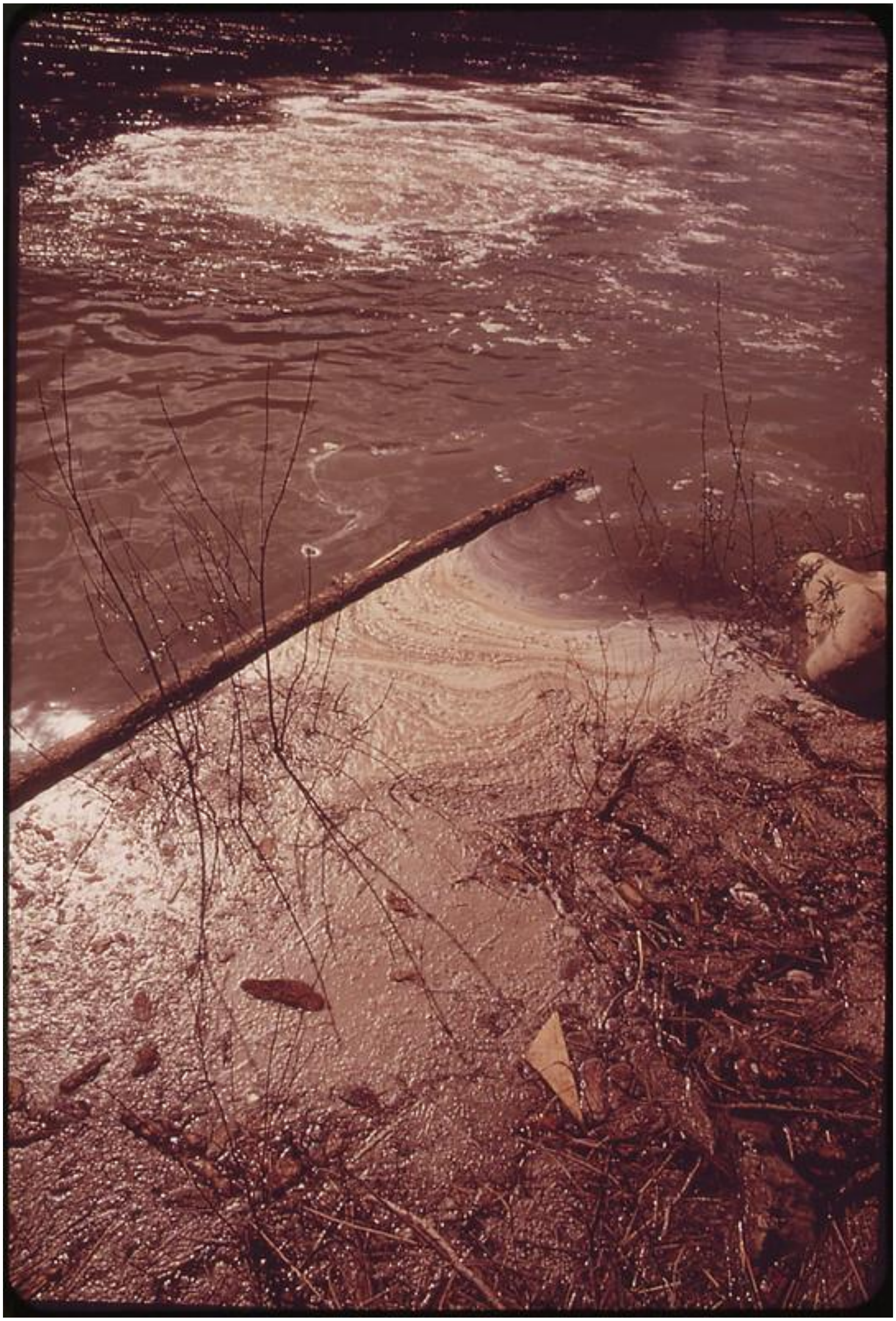


Chart 1.2 Raw Sewage Discharged from the City of Spokane Gathering Behind a Log in the Spokane River. Source: US EPA (1973).

Chart 1.3 Image of Raw Sewage Entering the Spokane River.[8] Source: Humphrey (2014).

1.4 City of Spokane Sewer System

There are a number of stormwater and wastewater conveyances operated by the City of Spokane that may be defined by the type of wastewater that they carry (sanitary waste, stormwater, or both) and their fate (the Riverside WWTP, the Spokane River, or both) (Figure 3).

- **Combined sewers** carry both stormwater and sewage to the Riverside WWTP. During wet weather, a portion of the flow is sent directly to the Spokane River without treatment. Before 1980, all of the sewers in Spokane were combined sewers, with overflow outfalls leading to the river. There are currently approximately 20 CSO outfalls in Spokane (Figure 4). As of 2019, there were still 10 uncontrolled outfalls in the City's sewer system (SWWM, 2019).
- **A municipal separated storm sewer system (MS4)** was completed in 1992 (CH2M HILL, 2014). The MS4 carries stormwater only, and discharges approximately 33% of the City's total stormwater volume. The MS4 system intentionally discharges stormwater that it carries directly to the Spokane River without treatment beyond limited settling of solids. There are more than 100 MS4 basins and outfalls to the river; six large basins (Cochran, Washington, Union, Kiernan, Hollywood, and Rifle Club) make up the majority of the system (Figure 3).
- **Sanitary sewers and incomplete separation sanitary sewers** carry wastewater directly to the Riverside WWTP. Sanitary sewers carry only sanitary waste, while some stormwater can enter the incompletely separated sanitary sewers during wet weather. Sanitary sewers and incomplete separation sanitary sewers have no direct outfalls to the river – wastewater is routed into the Riverside WWTP *via* interceptor sewers.

[8] This copyrighted material is being used for governmental regulatory/judicial purposes – no further reproduction is permitted without permission from the rights holder.

- **Infiltration and injection (I&I) and evaporation** is the final type of stormwater management in the City. I&I controls consist of dry wells and swales and are the sole stormwater controls outside the MS4 and "Special Drainage Districts" (SWWM, 2015a). In these systems, stormwater is discharged underground to groundwater, while a portion is lost to evaporation. The "Special Drainage Districts" are two areas in the northern and southern outskirts of the City, where stormwater is handled by evaporation.

Of the City of Spokane's stormwater, approximately one-third is handled by the MS4, one-third is handled by CSOs and incompletely separated sanitary sewers, and the remaining third is handled by I&I and evaporation, based on data from 2015 (SWWM, 2015b).

In response to regulatory orders to reduce CSO discharges to the Spokane River and to reduce stormwater loading to the river, since the mid-2000s, the City has engaged in a number of projects in its CSO and MS4 sewer systems. As discussed in detail in Section 5.6, the City was required to control its CSO discharges to the river by 2017 – a deadline the City did not meet. The City was granted an extension until December 31, 2019, to control all of its discharges. Ongoing and completed projects in CSO basins include storage tanks, elimination of outfalls, and installation of separated sewers, in effect transforming part of the CSO basin into an MS4 basin. In MS4 basins, the upgrades primarily include routing water to infiltration zones, routing water to treatment facilities, and installing drywells and other pipe infrastructure. In 2014, the City also decided to downsize its CSO tanks and at the same time install more MS4 projects within CSO basins (Condon, 2019; Hill, 2019; Davis, pp. 45-57 2019).

2 PCBs were formerly manufactured as a product and continue to be produced as a byproduct.

2.1 Product PCBs were manufactured as a bulk industrial chemical starting in the 1900s.

2.1.1 Properties of Product PCBs

PCBs were manufactured as products due to a variety of beneficial chemical properties, including non-flammability, low vapor pressure, wide compatibility with other chemicals, and overall durability. The primary industrial use of PCBs was in closed uses in the electrical industry for fire safety, in applications such as transformers and capacitors. The commercial uses of PCBs in electrical applications were based largely on their chemical properties, including non-flammability and insulating properties (Erickson and Kaley, 2011; ITF, 1972a; EPRI, 1999).

As a class of chemicals, PCBs have low vapor pressures (Hubbard, 1964; Erickson and Kaley, 2011), meaning that they do not easily volatilize. The low vapor pressure of PCBs was a favorable attribute for companies that manufactured PCB-containing open uses, such as caulks, sealants, and adhesives, because it meant that PCBs tended to remain in the application, extending the lifespan of the product.

Commercial uses of PCBs can be grouped into three categories (Erickson and Kaley, 2011):

- Completely closed systems, which are sealed off from the environment (*e.g.*, dielectric fluids in capacitors, transformers, electromagnets);
- Semi-closed systems, which are not entirely sealed off from the surrounding environment (*e.g.*, hydraulic systems, heat transfer fluids); and
- Open systems, in which the PCB-containing material is not contained in an enclosure but is part of a chemical matrix that contains it within a product (*e.g.*, coatings, inks, adhesives, plasticizers).

2.1.2 PCB Manufacture

PCBs were reported, in the German chemistry literature, to be first synthesized in 1881 (Schultz, 1881a,b; Schmidt and Schultz, 1881; Schultz *et al*., 1881; Hammond *et al*., 1972). Commercial PCB production (by the Swann Chemical Company) began in 1929 (ITF, 1972a; Monsanto, c. 1980; EPRI, 1999). In the early 1930s, General Electric (GE) patented the use of PCBs as non-flammable dielectric insulating fluids (Clark, 1933). In 1935, the Monsanto Company acquired the Swann Chemical Company, and from 1935-1977, Monsanto was the primary commercial producer of product PCBs in the US.[9]

[9] Geneva Industries in Houston, Texas, is the only other known PCB manufacturer in the US; it operated for 2 years (1972-1974) and produced a relatively small quantity of PCBs on the global scale (Breivik *et al*., 2007).

Monsanto sold mixtures of PCBs (and other polychlorinated compounds) under the trade name Aroclor (Monsanto, c. 1980). The most widely known Aroclors are PCBs, although the product line also included polychlorinated terphenyls (PCTs) and PCB/PCT blends. The naming convention includes the tradename Aroclor followed by a four-digit designation, in which the first two digits indicate the type of molecule (*i.e.*, "12" designated a biphenyl) and the last two digits indicate the approximate weight percentage of chlorine (Erickson and Kaley, 2011).

Monsanto manufactured PCBs in the US at facilities in two locations: Sauget, Illinois, and Anniston, Alabama (Versar, Inc., 1976). Monsanto did not have PCB manufacturing facilities within the Spokane River watershed and Monsanto has not been identified as an owner or operator of any of the facilities identified by the United States Environmental Protection Agency (US EPA) and WA Ecology as PCB sites in the Spokane River watershed (see Attachment 5). Monsanto did not discharge PCBs in the Spokane River.

In 1970, Monsanto voluntarily ceased sales of open-use PCB systems, and by 1972, had ceased sales of semi-closed systems (ITF, 1972b; Monsanto, c. 1980). After Monsanto limited sales of Aroclors starting in 1970, there is documented evidence of the importation of PCBs made by foreign manufacturers into the US. In multiple cases, Monsanto customers imported Kanechlors from Japan (Monsanto, 1970, 1971a,b). In other cases, customers simply reported that rather than use a non-PCB product from Monsanto, they would begin using imported PCBs until suitable replacements for Aroclors could be found (Smoke, 1971). From 1972-1974, Geneva Industries in Houston, Texas, produced PCBs (Breivik *et al*., 2007).

Monsanto voluntarily stopped PCB production in 1977 (Monsanto, c. 1980; Breivik *et al*., 2007). In 1979, US EPA required that manufacturing, processing, and distribution of PCBs all be ceased except in a "totally closed manner" under the Toxic Substances Control Act (TSCA) (US EPA, 1979 [44 FR 31514]). Byproduct PCBs were also exempted from this enforcement (see Section 2.2). The continued use of PCBs was expressly allowed under TSCA.

Global production of product PCBs between 1930 and 2012 is estimated to be approximately 3.0 billion pounds (CEC, 1996; Breivik *et al*., 2007). As summarized in Table 2.1, Monsanto's PCB production accounted for approximately 43% of that total (39% from the US and 4% from the UK), followed by producers in East Germany (18%), the Union of Soviet Socialist Republics (USSR)/Russian Federation (11%), West Germany (9.6%), France (8%), and Japan (3.5%) (CEC, 1996; Breivik *et al*., 2007). PCBs were also produced in several other countries at smaller volumes. Most global producers of PCBs ceased production by the 1980s. However, the Russian Federation continued to produce PCBs until 1993, and North Korea (also known as the Democratic People's Republic of Korea [DPRK]) continued PCB manufacturing until 2012 (IARC, 2015).

PCBs manufactured in foreign countries are largely indistinguishable from Monsanto Aroclors (Kannan *et al*., 1992; Erickson, 1997 92-1970a; De Voogt *et al*., 1990). Analytical methods used to quantify PCBs in environmental samples showed "striking" similarities between Aroclors, Kanechlor, Phenochlor, and Sovol mixtures (Morrison and Murphy 2006; Kannan *et al*., 1992).

Byproduct PCB production amounts have not been well established, but conservatively, at least millions of pounds of byproduct PCBs have been produced based on US EPA's 1983 estimate of byproduct PCB production (100,000 lbs/year) (US EPA, 1983). The City's expert witness concedes that the reported estimates of byproduct PCB production are likely underestimates and highly uncertain (Coghlan, 2019a, pp. 107-142).

The US EPA estimate is likely an underestimate of the total amount of byproduct PCBs produced, for several reasons:

- First, the economy has grown since the US EPA study in 1983, and the industries that produce byproduct PCBs have likely grown in scale.
- Second, US EPA does not enforce TSCA's 50 parts per million (ppm) limit for byproduct PCBs in products or processes (see Section 2.2.3), so byproduct PCBs could be present at much higher concentrations in these processes.
- Third, chemical manufacturers are not required to test for byproduct PCBs and there are likely more products or processes that produce byproduct PCBs than were known in 1983.

More recent partial estimates range from 900-2,200 lbs/year for total PCBs (Robinson, 2010) and 3,000-15,600 lbs/year globally for PCB 11 (Rodenburg *et al.*, 2010; Guo *et al.*, 2014), but, importantly, these estimates are limited to byproduct PCBs produced from pigments. In addition, Cui *et al.* (2013) reported that the emissions of byproduct PCBs from combustion processes in China have been increasing since the 1970s, and were estimated to be ~28,000 lbs/year in 2010. However, none of these more recent partial estimates can be directly compared to the initial US EPA estimate, because they do not encompass all the processes that can produce byproduct PCBs, which are associated with a variety of chemical and consumer products.

Table 2.1 Global PCB Production[a]

Country	Producer	Dates	Amount (Millions of Pounds)	Percentage of Total
US	Monsanto	1930-1977	1,414[b]	39%
	Geneva Industries	1972-1974	1	0.03%
UK	Monsanto	1954-1977	147	4.0%
Japan	Kanegafuchi	1954-1972	124	3.4%
	Mitsubishi	1969-1972	5.4	0.1%
Russian Federation (former USSR)	Orgsteklo	1939-1990	313	8.6%
	Orgsintez	1972-1993	71	1.9%
West Germany	Bayer AG	1930-1983	351	9.6%
East Germany[c]	Solvay-Werken Westeregeln	1955-1964	661	18%
France	Prodelec	1930-1984	297	8.1%
Spain	S.A. Cros	1955-1984	64	1.8%
Italy	Caffro	1958-1983	69	1.9%
Former Czechoslovakia	Chemko	1959-1984	47	1.3%
China[d]	Xi'an	1965-1980	22	0.6%
Poland	Electrochemical	1966-1970	2.2	0.06%
	Zaklady	1974-1977	1.5	0.04%
North Korea (Democratic People's Republic of Korea)[e]	2.8 Vinalon and the Sunchon Vinalon Complex	1960-2012	66	1.8%
	Total:	**1930-2012**	**2,993**	**100%**

Notes:
PCB = Polychlorinated Biphenyl; UK = United Kingdom; USSR = Union of Soviet Socialist Republics.
(a) Adapted from Breivik *et al*. (2007) and IARC (2015).
(b) Other sources indicate that Monsanto's US production of PCBs could have been between 1,100 and 1,450 millions of pounds (Versar, Inc., 1976).
(c) These estimates were obtained from CEC (1996), which identified a range of 454 to 661 million pounds.
(d) Estimated from The People's Republic of China "National Implementation Plan for the Stockholm Convention on Persistent Organic Pollutants" (2007), taken from IARC (2015).
(e) Estimated from The Democratic People's Republic of Korea "National Implementation Plan for the Stockholm Convention on Persistent Organic Pollutants" (2008), taken from IARC (2015).

2.1.3 Product PCB Uses

Product PCBs were primarily used in the electrical industry for fire safety because of their non-flammability (Penning, 1930; ITF, 1972a; EPRI, 1999). In fact, 77% of total PCB domestic usage was for fire safety in electrical fluid applications; 6.4% of total PCB usage was for fire safety in hydraulic fluid applications; and another 1.6% was used for heat transfer system fluids, for which PCB non-flammability was a critical benefit (US EPA, 1997a; Erickson and Kaley, 2011; Versar, Inc., 1976).

In 1970, Monsanto ceased sales of open-use PCB systems, and by 1972, had ceased sales of semi-closed systems (ITF, 1972b; Monsanto, c. 1980). After Monsanto limited sales to only closed systems starting in 1972, essentially 100% of PCB sales in the US were for electrical applications. The commercial uses of PCBs in electrical applications were based largely on their chemical properties, including non-flammability and insulating properties (ITF, 1972a; Erickson and Kaley, 2011; EPRI, 1999). The Interdepartmental Task Force on PCBs (ITF) in 1972 stated that "[t]heir continued use for transformers and capacitors in the near future is considered necessary because of the significantly increased risk of fire and explosion and the

disruption of electrical service which would result from a ban on PCB use" (ITF, 1972a). Monsanto voluntarily stopped PCB production in 1977 (Monsanto, c. 1980; Breivik *et al*., 2007).

Open uses included applications such as coatings, inks, adhesives, varnishes, and plasticizers. PCBs used as plasticizers in sealants or caulks were intended to remain in place (Erickson and Kaley, 2011); in fact, a note in the Federal Register accompanying the 1979 TSCA regulation stated that "[t]his Subpart does not require removal of PCBs and PCB items from service and disposal earlier than would normally be the case" (US EPA, 1979 [44 FR 31514]).

Monsanto, as a raw material supplier, sold a wide range of products used in plasticizers to industrial customers, who would combine them with other materials to make end products. A small percentage of Monsanto's products used in plasticizers were Aroclors; plasticizers containing Aroclors represented approximately 1% of the total plasticizer market in the 1950s and 1960s (US Tariff Commission, 1950, 1952-1960, 1963-1965, 1968; ITF, 1972a).

2.1.4 PCB Congeners

There are 209 different individual PCB congeners, which make up the class of chemicals referred to as PCBs. Aroclors[10] and other non-Aroclor product PCB formulations produced by other companies throughout the world are compositions of many different congeners at varying concentrations. The 209 PCB congeners all contain the basic biphenyl molecule structure but differ by the number (up to 10) and position of chlorine atoms on the molecule. The PCB congeners are identified as PCB 1 through PCB 209. PCB congeners with the same number of chlorine atoms (regardless of position) are part of the same homolog group.

The chemical properties of PCBs vary with the degree of chlorination and position of the chlorine atoms on the molecule. While PCBs as a class of chemicals have low solubility and low vapor pressure relative to other organic chemicals, less-chlorinated PCB congeners are more soluble and more volatile than higher-chlorinated PCB congeners. Similarly, higher-chlorinated PCB congeners are more resistant to degradation and tend to bind more to solid particles, such as sediments, than less-chlorinated PCB congeners.

In addition to having a range of chemical properties, individual PCB congeners or groupings of PCB congeners (*i.e*., "fingerprints") can be used to help identify the likely original source of the PCBs. For example, PCB 11 is widely identified as a byproduct PCB that is associated with pigment production (Vorkamp, 2016 and references within; Rodenburg *et al*., 2010). The presence of PCB 11 in the environment points to non-Monsanto sources of pigments or dyes in the environment. Some researchers look for PCB 11 as an obvious example of a byproduct PCB congener, but there are approximately 150 PCB congeners that have been produced as byproducts. Therefore, any analysis that only looks at a few congeners is not representative of the overall presence of byproduct PCBs. Aroclors and other product PCBs have distinct patterns of multiple dozens of PCB congeners. If these patterns of PCB congeners are found in the environment, it may be possible to identify the likely Aroclor (or other product PCB formulation) they came from and the product uses associated with that Aroclor (or other product PCB formulation).

[10] As described above, the term Aroclor is a Monsanto trade name (Monsanto, c. 1980); the most widely known Aroclors are made of PCBs, although the product line also included PCTs and PCB/PCT blends.

2.1.5 PCB Regulations

In 1971, the federal government formed the ITF in an attempt to synthesize the available scientific information on PCBs (Burger, 1976). The ITF, which comprised participants from US EPA; the United States Food and Drug Administration (US FDA); the United States Department of Agriculture (USDA); Department of Commerce; the Department of Health, Education, and Welfare; the National Institute of Environmental Health Sciences (NIEHS); and the Department of the Interior; as well as leading scientists from academia and industry, reported in 1972 that the use of PCBs in electrical equipment was essential to the safe delivery of electrical power in the US: "Their continued use for transformers and capacitors in the near future is considered necessary because of the significantly increased risk of fire and explosion and the disruption of electrical service which would result from a ban on PCB use" (ITF, 1972a).

Congress enacted TSCA in 1976, which gave US EPA the authority to regulate the manufacture, distribution, use, and disposal of chemical substances and mixtures (excluding food, drugs, cosmetics, pesticides, and other substances regulated under other statutes or governmental bodies). Starting in 1978, US EPA amended TSCA to impose new requirements for the handling and disposal of PCBs. In 1979, US EPA required that the manufacturing, processing, and distribution of PCBs all be ceased except in a "totally closed manner" under TSCA (US EPA, 1979 [44 FR 31514]). Byproduct PCBs were also exempted from this enforcement (see Section 2.2).

Following the 1979 TSCA regulation, the federal government controlled PCB use, remediation, and disposal. In 1979, the continued use of PCBs was allowed in certain applications, specifically in electrical systems, certain products, and at certain levels in food set by US FDA.

2.2 Byproduct PCBs

2.2.1 Formation of Byproduct PCBs

In addition to "product" PCBs such as Aroclors, PCBs are generated as a byproduct of many different industrial processes that involve the presence of chlorine, carbon, and high temperatures (Hu and Hornbuckle, 2010). These "byproduct PCBs" (also referred to as "inadvertently generated PCBs") are not Monsanto Aroclors. Byproduct PCBs have been produced globally both before and after TSCA was enacted.

Byproduct PCBs are produced in pigment production, but also during other chemical manufacturing and combustion processes. Byproduct PCBs are associated with the production of organic pigments due to the use of certain chlorine-containing raw materials or chlorinated solvents in these processes. They are also associated with the production of the inorganic pigment titanium oxide. Attachment 3 summarizes the congeners detected in various pigment categories, including titanium dioxide (white), azo-type pigments (yellow, orange, and red), phthalocyanine pigments (blue and green), dioxazine and diketopyrrolopyrrole (red, green, and violet), and various other types of pigments. Byproduct PCBs are also produced during other chemical manufacturing and combustion processes in which chlorine, carbon, and high temperatures are present.

Approximately 150 PCB congeners have been identified as byproduct PCBs; many of these congeners overlap with the PCB congeners found in Aroclors (Chart 2.1; Attachment 3).

Non-pigment-related chemicals and processes that are associated with byproduct PCBs include silicone products and their precursors, the manufacturing of metallic titanium, combustion processes, and the synthesis of dozens of organic chemicals. Silicone products and their precursors that contain byproduct PCBs include silicone-based glues (Anezaki and Nakano, 2013), silicone rubbers (Perdih and Jan, 1994), and silicone tubing (Cargill, 2014; Rodenburg, 2012, 2016). The production of certain metallic titanium involves the reaction of chlorine and coke at high temperatures and has the potential to produce byproduct PCBs (Attachment 3). Combustion processes can produce byproduct PCBs, along with polychlorinated dibenzo-p-dioxins and dibenzofurans (PCDDs/PCDFs) and the City has acknowledged this (Coghlan, 2019a, pp. 76-83).

During the rulemaking process regarding exemptions for byproduct PCBs, US EPA identified approximately 200 chemical products or chemical compound classes with the potential to generate byproduct PCBs during their production (Cristol, 1983) (Table 2.2; Attachment 3). According to the Chemical Manufacturers Association, "PCBs can be generated from virtually any starting hydrocarbon structure," and "PCB formation appears to be possible whenever chlorine and carbon are present in a reaction vessel at elevated temperatures" (US EPA, 1982a). This list identified by US EPA in the 1980s was not necessarily complete, however. Rather, it was a list of the chemicals known at the time to have the potential to produce byproduct PCBs. US EPA did not do a comprehensive inventory of every chemical process in the US in the 1980s, and this list is not representative of the wider universe of chemical manufacturing that occurs today in the US, approximately 40 years after US EPA released this list.

Homolog Group	Individual Congeners																																													
mono	1	2	3																																											
di	4	5	6	7	8	9	10	11	12	13	14	15																																		
tri	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39																						
tetra	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81				
penta	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127
hexa	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169				
hepta	170	171	172	173	174	175	176	177	178	179	180	181	182	183	184	185	186	187	188	189	190	191	192	193																						
octa	194	195	196	197	198	199	200	201	202	203	204	205																																		
nona	206	207	208																																											
deca	209																																													

Chart 2.1 Congeners Associated with Various Byproduct PCB Processes. PCB = Polychlorinated Biphenyl. Congeners are grouped by homolog group. Blue highlighting = Detection of congener in connection to at least one byproduct PCB process. Sources: Hu and Hornbuckle (2010); Anezaki *et al*. (2014); Anezaki and Nakano (2013, 2014, 2015); WA Ecology (2014b); Perdih and Jan (1994); Law (1995); Shang *et al*. (2014); Huang *et al*. (2015); Liu *et al*. (2013a); Liu *et al*. (2013b); Ishikawa *et al*. (2007); Jiang *et al*. (2015); Kim *et al*. (2004); Takasuga *et al*. (2014).

Table 2.2 Chemicals Identified in the 1980s with a High Potential to Generate Byproduct PCBs During Their Production, as Determined by US EPA

Compounds or Compound Classes	
Allyl Alcohol	Chlorinated Fluorinated Methanes
Allyl Amines	Chlorinated Methanes:
Aluminum Chloride	Carbon Tetrachloride
Aminochlorobenzotrifluoride	Chloroform
Aminoethylethanolamine	Methyl Chloride
Benzene Phosphorus Dichloride	Methylene Chloride
Benzophenone	Chlorinated Naphthalenes
Benzotrichloride	Chlorinated Pesticides
Benzoyl Peroxide	Chlorinated Pigments/Dyes
Carbon Tetrabromide	Chlorinated Propanediols
Carbon Tetrafluoride	Chlorinated Propanols:
Chlorendic Acid/Anhydride/Esters	Dichlorohydrin
Chlorinated Acetophenones	Propylene Chlorohydrin
Chlorinated Benzenes:	Chlorinated Propylenes
Dichlorobenzenes	Chlorinated Unsaturated Paraffins
Hexachlorobenzenes	Chlorobenzaldehyde
Monochlorobenzene	Chlorobenzoic Acid/Esters
Pentachlorobenzene	Chlorobenzoyl Peroxide
1,2,4,5-Tetrachlorobenzene	Chlorobenzyl Hydroxyethyl Sulfide
Trichlorobenzene	Chlorobenzyl Mercaptan
Chlorinated Benzotrichlorides	bis (2-Chloroisopropyl) Ether
Chlorinated Benzotrifluorides	Dimethoxy Benzophenone
Chlorinated Benzylamines	Dimethyl Benzophenone
Chlorinated Brominated Ethylenes	Diphenyl Oxide
Chlorinated Brominated Methanes	Epichlorohydrin
Chlorinated Ethanes:	Ethylene Diamine
1,1-Dichloroethane	Glycerol
1,2-Dichloroethane	Hexachlorobutadiene
Hexachloroethane	Hexachlorocyclohexane
Monochloroethane	Hexachlorocyclopentadiene
1,1,2,2-Tetrachloroethane	Linear Alkyl Benzenes
1,1,1-Trichloroethane	Methallyl Chlorides
1,1,2-Trichloroethane	Pentachloronitrobenzene
Chlorinated Ethylenes:	Phenylchlorosilanes
1,1-Dichloroethylene	o-Phenylphenol
1,2-Dichloroethylene	Phosgene
Monochloroethylene	Propylene Oxide
Tetrachloroethylene	Tetrachloronaphtalic Anhydride
Trichloroethylene	Tetramethylethylene Diamine
Chlorinated Fluorinated Ethanes	Trichlorophenoxy Acetic Acid
Chlorinated Fluorinated Ethylenes	

Notes:
PCB = Polychlorinated Biphenyl; ppm = Parts Per Million; US EPA = United States Environmental Protection Agency.
Shaded Chemicals = Those identified to contain more than 50 ppm PCB concentration at the point of manufacture based on petitions submitted to US EPA (Callahan *et al.*, 1983).
Adapted from Callahan *et al*. (1983).

2.2.2 Products Containing Byproduct PCBs

Byproduct PCBs are found in consumer and industrial products. WA Ecology performed two studies to evaluate the presence of byproduct PCBs in a variety of consumer products (WA Ecology, 2014b, 2016a). The City of Spokane also investigated PCBs in municipal products that the City purchases that are commonly used in road and facility maintenance, such as road paint, asphalt sealers, pesticides, deicers, and others (SWWM, 2015c). Samples of some of these products were also sent to WA Ecology for analysis and were included in the WA Ecology (2016a) study. These studies showed the presence of byproduct PCBs in a wide range of consumer products, with the highest concentrations (1,000-2,320 parts per billion [ppb]) found in yellow sidewalk chalk, cereal packaging, and "yellow foam office product" (WA Ecology, 2016a).[11] The majority of the products had between one and five PCB congeners present. PCBs 11, 209, and 12/13 accounted for the majority of the congeners for products in which only one congener was detected. The most frequently detected congeners were PCBs 11, 52, 61/70/74/76, and 31, and these were attributed to the presence of dyes and pigments in the products.

In pigments, concentrations of byproduct PCBs can be much higher. The Ministry of Economy, Trade and Industry (METI) in Japan documented PCB concentrations in yellow pigments of 50-2,000 ppm and in red pigments of 37-208 ppm (Christie, 2016).

2.2.3 Regulation of Byproduct PCBs

The presence of byproduct PCBs in various products and processes was known at the time of the TSCA PCB action in 1979 (Cairns and Siegmund, 1981; US EPA, 1983) and TSCA allowed for the continued production of PCBs as a byproduct in other manufacturing processes. TSCA set a nominal concentration limit of 50 ppm for byproduct PCBs in products (US EPA, 1979); however, the regulation contains no requirement for testing, US EPA has stated that the enforcement of this concentration limit for all products is not practical (McLerran, 2015), and it is known that US EPA does not enforce this limit (Rodenburg, 2018). Byproduct PCB concentrations can be regularly much higher than 50 ppm in pigments and other products (Section 2.2.2).

2.2.4 PCB Congeners Strongly Indicative of Byproduct PCBs

One way to assess whether PCB congeners identified in environmental samples are strongly indicative of byproduct PCB sources as opposed to Aroclor sources is to identify those byproduct PCB congeners that are not present in Aroclors at appreciable quantities and that are also not products of reductive dechlorination of Aroclor mixtures. For simplicity, PCB congeners that are strongly indicative of byproduct PCBs are referred to as "byproduct PCBs." The two most widely cited studies that reported detailed and quantitative PCB congener compositions for the PCB Aroclor mixtures sold by Monsanto are Frame *et al*. (1996) and Rushneck *et al.* (2004).

[11] WA Ecology (2016a) also refers to this product as "Yellow Glitter Foam Sheet," which appears to be an arts and crafts product with glitter and a peel-and-stick back.

Using the reported PCB congener composition of Aroclors from these two studies,[12] we defined PCB congeners that are strongly indicative of byproduct PCBs, based on the following criteria:

- Byproduct congeners that represent less than 0.1% by weight in any individual high-production-volume Aroclors,[13] as reported in either Frame *et al*. (1996) or Rushneck *et al.* (2004);[14] and
- Byproduct congeners not likely to be derived from the dechlorination of other congeners present in Aroclor mixtures at greater than 1% by weight, as reported in either Frame *et al*. (1996) or Rushneck *et al.* (2004).

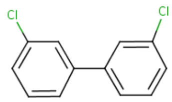
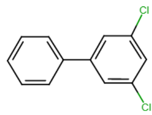
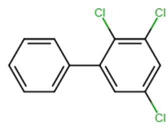
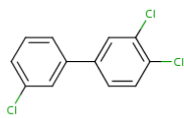
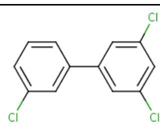
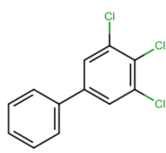
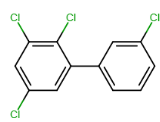
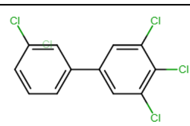
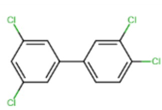
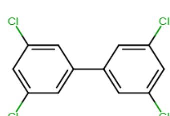
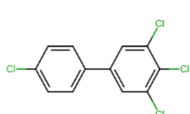
Using these criteria, the congeners strongly indicative of byproduct PCB congeners are summarized in Table 2.3 and in Attachment 3; importantly, there are many other PCB congeners that may be associated with byproduct PCBs – this is only a subset. Approximately 150 congeners have been identified so far as capable of being produced as byproducts during other chemical processes. Many of these 150 byproduct PCB congeners overlap with congeners that were found in Aroclors.

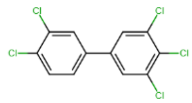
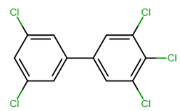
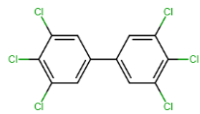
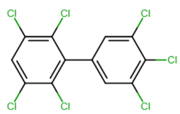
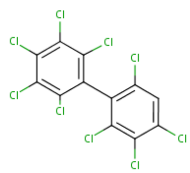
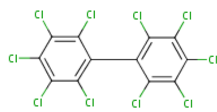
[12] PCB congener compositions can vary between different Aroclor lots; I examined several studies besides Rushneck *et al.* (2004) and Frame *et al*. (1996) to check whether analytical and interlot variability could impact the results, as detailed in Attachment 3, Sections A3.4.1 and A3.4.2.

[13] High-production-volume PCB Aroclors (*i.e*., Aroclors 1016, 1242, 1248, 1254, and 1260) are defined as those that account for 97.6% of Monsanto's total estimated PCB Aroclor production from 1954 to 1974 (Versar, Inc., 1976). Monsanto also produced several other PCB Aroclors (*i.e*., Aroclors 1221, 1232, 1262, and 1268) at much lower production volumes, but these accounted for less than 1% each of Monsanto's total PCB Aroclor production.

[14] As part of this analysis, I also examined which congeners represent less than 0.01% and 0.05% by weight of any individual high-production-volume Aroclors. Five congeners satisfy the 0.01% criteria and thirteen congeners satisfy the 0.05% criteria. However, I determined that these weight composition thresholds were inappropriate, because PCB 209 and PCB 11 (two widely cited byproduct PCBs) do not satisfy these criteria.

Table 2.3 PCB Congeners That Are Strongly Indicative of Byproduct PCB Sources

PCB Congener	Structure	Product/Industry	Weight Percentage in High Production Volume Aroclors[a]	Weight Percentage in Low Production Volume Aroclors[b]
11		Pigments; silicone; combustion	ND-0.018%	ND-0.16%
14		Pigments; silicone; combustion	ND	0.02%
23		Pigments	0.001-0.052%	0.001-0.023%
35		Pigments; combustion	ND-0.08%	ND-0.0019%
36		Pigments	ND	ND
38		Pigments	0.002-0.029%	n.d.-0.001%
57		Combustion	0.013-0.022%	0.001-0.013%
78		Pigments; combustion	0.006-0.018%	ND
79		Pigments; combustion	0.002-0.099%	0.001-0.007%
80		Pigments	ND	ND
81		Pigments; other chemicals; combustion	0.014-0.026%	0.010-0.011%

PCB Congener	Structure	Product/Industry	Weight Percentage in High Production Volume Aroclors[a]	Weight Percentage in Low Production Volume Aroclors[b]
126		Pigments; other chemicals; combustion	0.001-0.019%	0.001-0.003%
127		Pigments; combustion	0.001-0.012%	ND
169		Pigments; other chemicals; combustion	0.001-0.006%	0.001-0.006%
192		Combustion	ND	ND
207		Pigments	ND-0.065%	ND-2.94%
209		Pigments; other chemicals; combustion	ND-0.082%	ND-7.29%

Notes:
ND = Not Detected; PCB = Polychlorinated Biphenyl.
Source: Attachment 3.
(a) Using Frame *et al*. (1996) and Rushneck *et al*. (2004). Aroclors 1016, 1242, 1248, 1254, and 1260, which together accounted for 97.6% of all PCB Aroclor production between 1957 and 1974 (Versar Inc., 1976).
(b) Using Frame *et al*. (1996) and Rushneck *et al*. (2004). Aroclors 1221, 1232, 1262, and 1268, which individually accounted for less than 1% of total PCB Aroclor production between 1957 and 1974 (Versar Inc., 1976).

3 The Fate and Transport of PCBs in the Environment

At the time of Mr. Soren Jensen's discovery of PCBs in the environment in 1966 (New Scientist, 1966), scientists did not look for or expect to find PCBs in the environment. Unlike DDT (dichlorodiphenyltrichloroethane), which had been widely used for agricultural pest and disease vector control since the 1940s (US Navy, 1944; Hess and Keener, 1947; USDA, 1947) and whose presence in the environment had been identified (Middleton and Rosen, 1956; Nicholson, 1959), the presence of PCBs in the environment was not well understood in the mid-1960s. The use pattern of PCBs was very different than DDT, which was applied directly to the environment as its intended use. PCBs were largely contained inside closed uses (such as transformers) or embedded within plastic matrices such as caulk. Furthermore, the chemical properties of PCBs, such as low solubility and low vapor pressure, meant that PCBs in products were expected to remain inside the products and selected for this purpose.

Additionally, at the time of Mr. Jensen's discovery of PCBs in the environment, there was limited scientific understanding of the global movement of chemicals between different environmental media. Reports from three different government groups (the Panel on Hazardous Trace Substances [PHTS], the ITF, and the NIEHS Conference on PCBs), all issued in 1972, identified major uncertainties in the understanding of PCB environmental fate and transport. The reports agreed that, despite the increased number of PCB studies being published, there were key data gaps regarding the distribution of PCBs in the environment, and regarding the mechanisms of removal, degradation, and sequestration of PCBs in different media (Hammond *et al*., 1972; ITF, 1972a). For example:

- "The recommendation by the task force that 'more scientific information about PCBs is needed' is illustrated by the paucity of knowledge about PCBs in the environment. Only general statements can be made about how PCBs reach the environment, how they reach target organisms and how much is present" (ITF, 1972a);
- "There are few data on the removal, disappearance, and sequestering of the substances [PCBs] in soils or bottom sediments of rivers, lakes, estuaries, or the ocean" (ITF, 1972a);
- "As yet little is known of the distribution of PCBs in terrestrial environments" (Hammond *et al*., 1972); and
- "However, perhaps the major finding of this study is that research on the environmental effects of PCBs has been piecemeal and insufficiently coordinated. Despite the large number of detailed studies of PCBs conducted in the last four years, it has proved difficult to assemble the results into a coherent picture because important pieces of the puzzle are missing" (Hammond *et al*., 1972).

In his then-retrospective evaluation of the issues surrounding the environmental discovery and subsequent regulation of PCBs, Dr. Edward Burger, from the Office of the President's Science Advisor, Science and Technology Policy Office, emphasized that in 1971, "[t]he scientific issues were still not clear and there were glaring gaps in information" (Burger, 1976). The World Health Organization (WHO) also reviewed the available scientific literature pertaining to PCBs as of 1976, and that review again serves to highlight the limited understanding of the fate and effects of PCBs in the environment at that time (IPCS, 1976). A 1970s Monsanto memorandum that mistakenly postulated that PCBs in the environment were from open uses (Monsanto, 1975) similarly reflects the limited understanding of PCB fate and transport at that time.

3.1 The scientific understanding of PCB fate and transport developed gradually over time.

The scientific ability to identify specific PCB sources and to understand PCB fate and transport developed gradually over time. Indeed, the first textbooks on contaminant fate and transport were not published until 1979/1980,[15] the first mention of "fate and transport" in a published study related to PCBs was not until in 1978 (Paris *et al*., 1978), and US EPA did not publish an analytical method capable of resolving all 209 PCB congeners until 1999 (1668A; US EPA 1999).

During the 1960s and 1970s, there was new public and regulatory awareness of chemicals in the environment. For example, US EPA was established in 1970 and the Federal Water Pollution Act was significantly amended in 1972 and became known as the Clean Water Act. These acts and federal funding for universities and agencies helped spur research and investment to understand how chemicals behave in the environment (Anderson, 2002). Fate and transport modeling advancements from the 1960s to the early 1980s (*e.g*., the HSPF [Hydrological Simulation Program – FORTRAN] model, which simulates watershed hydrologic processes; the MODFLOW model, which simulates groundwater flow) provided scientists with tools for understanding and predicting the behavior of chemicals, such as PCBs, in the environment (Swann and Eschenroeder, 1983).

Published scientific literature on PCBs serves as an indicator of how the scientific awareness and knowledge of PCB fate and transport developed gradually over time. Chart 3.1 depicts the results of three targeted searches of published scientific papers in the Scopus database,[16] grouped by 5-year intervals:

- **Search A terms:** "PCB"[17]and "fate and transport."
- **Search B terms:** "PCB"[18] and "environment."
- **Search C terms:** "Fate and transport" only.

Between 1970 and 2015,[19] the number of papers on PCBs and the environment increased significantly (Search B), as did articles that more broadly discussed fate and transport (Search C). Journal articles that specifically discussed PCB fate and transport (Search A) represent a small fraction of the published literature on both fate and transport (Search C) and PCBs in the environment (Search B). As these literature search results illustrate, the amount of scientific literature on these topics prior to 1970 was very limited and is indicative of the limited scientific understanding of PCB fate and transport.

---

[15] *e.g.*, Lippmann and Schlesigner (1979): *Chemical Contamination in the Human Environment*; Thibodeaux (1979): *Chemodynamics: Environmental Movement of Chemicals in Air, Water, and Soil*; Neely (1980): *Chemicals in the Environment: Distribution, Transport, Fate, Analysis*; Baker (1980): *Contaminants and Sediments – Volume 1: Fate and Transport, Case Studies, Modeling, Toxicity*.

[16] The Scopus database includes scientific literature from more than 20,000 journals published throughout the world.

[17] Polychlorinated Biphenyl, Aroclor, Arochlor, Araclor, Arachlor, Askarel, and Pyranol were all used as variants of "PCB" in Search A.

[18] Polychlorinated Biphenyl, Aroclor, Arochlor, Araclor, Arachlor, Askarel, and Pyranol were all used as variants of "PCB" in Search A.

[19] Less than 4 years of publications (2016 through the available portion of 2019) are currently available for the 2016-2020 interval, so this interval was not plotted.

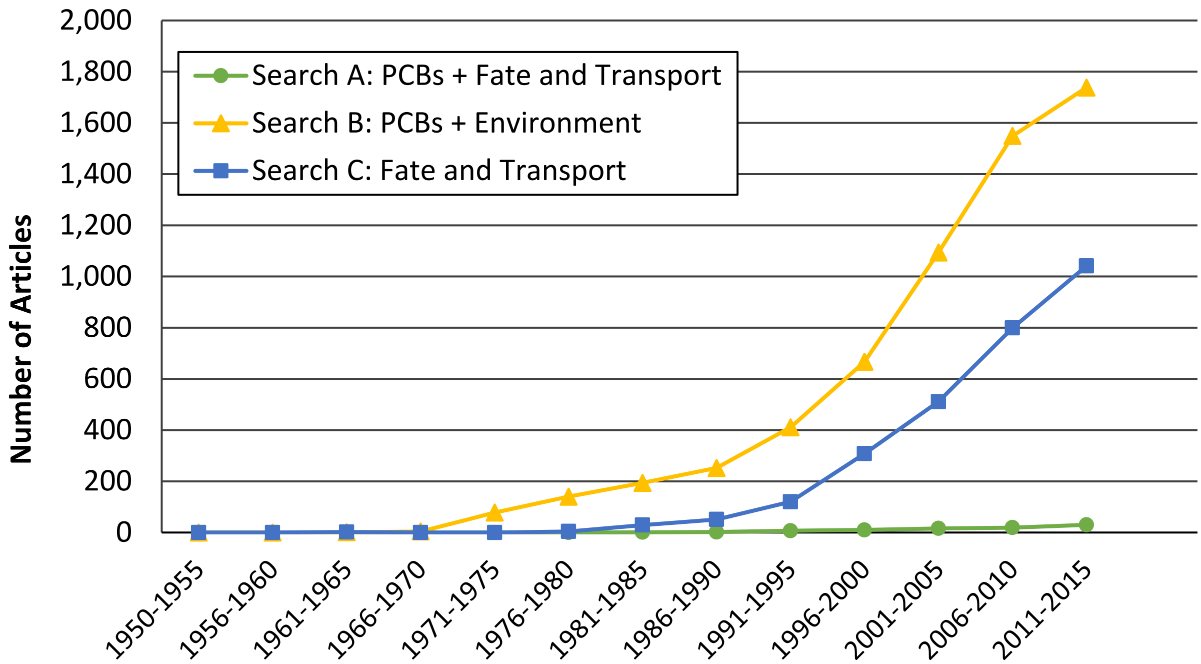


Chart 3.1 PCB Peer-reviewed Literature Articles (1950-2015). * = Studies published from 1950 through 2015 are grouped into 5-year intervals. No studies were found that met these search criteria from before 1950. Less than 4 years of publications (2016 through the available portion of 2019) are currently available for the 2016-2020 interval so this interval was not plotted. Search A terms: PCB, Polychlorinated Biphenyl, Aroclor, Arochlor, Araclor, Arachlor, Askarel, or Pyranol, and fate and transport. Search B terms: PCB, Polychlorinated Biphenyl, Aroclor, Arochlor, Araclor, Arachlor, Askarel, or Pyranol, and environment. Search C terms: "Fate and transport" only.

The limited discussion of PCBs in early scientific literature is consistent with the scientific focus at that time on "conventional" parameters (*e.g.*, BOD, total suspended solids [TSS]) that could be measured using then-existing technology. While capable of providing a general indication of a water body's quality, these parameters do not provide information on specific chemicals' presence and their relative contribution to observed effects (if any). Nonetheless, scientists could use these parameters to develop a scientific understanding of various fate and transport processes (*e.g.*, dilution effects) that became a bridge to a more-sophisticated understanding of specific chemicals' behavior in the environment.

While the understanding of the environmental transformations of PCBs has evolved from these early studies, current research underscores the complexities of PCB dechlorination and biodegradation, and this scientific understanding continues to evolve (Erickson, 1997). For example, not only the degree of chlorination, but the position of chlorine atoms on the biphenyl molecule, aerobic *versus* anaerobic conditions, temperature, and nutrient levels for microbial populations are some of the factors that influence PCB degradation (Kalmaz and Kalmaz, 1979; Brown *et al*., 1987; Erickson, 1997). The possibility of PCB degradation through reductive dechlorination was first identified in 1980s studies of the upper Hudson River (Morrison and Murphy, 2006).

3.2 The ability to accurately identify and quantify PCBs in the environment continues to develop.

Mr. Jensen's first reported discovery of PCBs in December 1966 (New Scientist, 1966) triggered a succession of studies that revealed PCBs in multiple environmental media. Many of these studies were aimed at improving PCB analytical methods. As noted by Peakall and Lincer (1970), "[i]t is clear that we are still relatively unsophisticated in our PCB quantitation methodology and will continue to estimate only relative amounts of PCBs in field samples." By 1972, Webb and McCall published an analytical method to refine PCB analysis (Webb and McCall, 1972), although this method was not adopted by US EPA until 1982 (US EPA, 1982b). Because PCBs are mixtures of 209 compounds, each with different physicochemical properties, chemical analysis remains a challenging technical issue.

Early efforts to characterize the presence of PCBs in the environment were often hindered by the difficulties associated with analytical methods. Early analytical methods often failed to resolve PCBs from other chlorinated hydrocarbons, such as DDT, and could not separate the 209 PCB congeners from each other. In 1970, Armour and Burke (1970) published a method of using a column "cleanup" technique to separate PCBs from DDT prior to gas chromatography (GC) analysis. Other researchers offered improvements to PCB extraction and separation techniques (Benevue and Ogata, 1970; Bagley *et al*., 1970; Gustafson, 1970; Dvorak *et al*., 1971; Leoni, 1971). In 1972, Webb and McCall (1972) formalized a method for quantifying PCBs as Aroclors using a few discriminating GC peaks. This method worked for samples that retained an Aroclor-like signature, but was often inaccurate when applied to non-Aroclor releases, mixtures, and Aroclor releases that had been subjected to weathering (Shifrin and Toole, 1998). It was not until 1985 that US EPA published a method (US EPA Method 680) that detected and quantified PCBs by homolog group (US EPA, 1985a-c), and could be supportive of identifying byproduct PCBs, but still did not resolve each individual PCB congener.

Importantly, until the late 1990s, the lack of an approved US EPA method for congener-specific PCB analysis impacted the scientific ability to understand PCB sources, fate, and transport, let alone at parts per quadrillion (ppq, equivalent to pg/L) concentrations in water. US EPA first published US EPA Method 1668 (US EPA, 1997b) in 1997, but the first version of the method focused just on the 12 co-planar congeners (by International Union of Pure and Applied Chemistry [IUPAC] number) designated as "toxic" by the WHO, also known as dioxin-like PCBs: 77, 105, 114, 118, 123, 126, 156, 157, 167, 169, 170, 180, and 189. In 1999, US EPA came out with a revision of the method (US EPA 1999), which can be used to quantify all 209 congeners. This was an important milestone, because it provided scientists with the ability to discern PCB sources and environmental transformation processes.

4 PCB levels in the Spokane River are below regulatory levels, have declined, and are expected to continue declining.

4.1 PCB Mass Loading in the Spokane River

Comprehensive mass loading studies of PCB discharges to the Spokane River and in-river PCB loads at stations in the river can be used to determine:

- Where the majority of the PCB load comes from, and the relative fraction of the PCB load due to the City of Spokane's municipal (MS4, CSO, and WWTP) discharges; and
- If the PCBs in the river are accounted for by known sources of discharges.

4.1.1 Upstream loads and industrial discharges account for the vast majority of PCBs in the Spokane River as it flows past the City.

A number of studies have examined the loadings from known individual dischargers and from sources upstream of the City of Spokane (WA Ecology, 2011a; LimnoTech, 2016a). The vast majority of the PCB load in the river is due to sources upstream of the City – the City's contribution to the PCB load in the river is relatively minor in comparison. Upstream sources of PCB loading to the river include loads originating in Idaho, loads originating from municipalities upstream of Spokane, and known industrial dischargers such as Kaiser Aluminum and the Inland Empire Paper Company (IEP). This fact is also acknowledged by the City's expert witness Dr. David Dilks. In his expert report, Dr. Dilks states that at the baseline loading rate from 2007, the Spokane River loading from upstream the City boundary (1,475 mg/day, equal to 0.052 ounces/day) is more than four times larger than the combined City load from the MS4, CSO, and WWTP discharges (359 mg/day, equal to 0.0127 ounces/day) (Dilks, 2019). Based on these findings, which are drawn from numerous Task Force and WA Ecology-led studies over the past decade, the City's total load is minor compared with the already existing PCB load in the river as it enters the City of Spokane.

Importantly, the Task Force sampling has confirmed that the in-river loads are already lower than both the Washington State Water Quality Standard and the US EPA National Primary Drinking Water Regulation for PCBs (Section 4.2). In other words, but for the presence of metals, raw sewage, and other substances, water from the Spokane River would be safe to drink.

4.1.2 The PCBs found in the river are accounted for by known discharges and upstream sources.

To date, the most comprehensive synoptic survey of in-river loadings and discharger loadings is the 2014 Task Force low-flow synoptic survey, which occurred in August 2014, during a period of minimal precipitation and corresponding low river flow (LimnoTech, 2015b). The loadings from this survey are summarized in Table 4.1 and plotted in Chart 4.1. In this chart, dischargers are plotted by river mile (from Coeur d'Alene, Idaho, in the east, to Nine Mile Dam near Spokane, Washington, in the West) as red circles,

with the cumulative mass loading from these dischargers[20] depicted as a dashed red line. In-river loads (based on measured PCB concentration and in-river flows measured at river gages) are depicted as blue circles, while the cumulative in-river load is shown as a solid blue line. In addition to the in-river locations and certain known dischargers sampled in the 2014 low-flow program, Chart 4.1 includes the groundwater load that was identified in part due to the 2014 low-flow sampling. This groundwater loading from the reach near Kaiser Aluminum was estimated to be approximately 130 mg/day (0.00459 ounces/day) in magnitude (LimnoTech, 2016a).

The 2014 Task Force synoptic survey confirms that at low-flow conditions in the river, the PCB mass loading in the river is accounted for by the known sources of discharges. That is, the calculated loadings from the primary industrial dischargers and the primary pathways (*e.g.*, sewers, upstream loading from Idaho) match the total PCB loading in the river. As shown in Chart 4.1, there is very close agreement between the measured in-river loads at multiple stations along the Spokane River and the calculated discharger loads from known dischargers and tributaries starting downstream of Lake Coeur d'Alene. If the blue line of in-river loadings was significantly higher than the cumulative discharges red line, it could indicate an unaccounted-for PCB load in the river. However, the blue and red lines show close agreement for points downstream of Lake Coeur d'Alene, indicating that the measured in-river loadings are accounted for by the known dischargers.

As part of my analysis, I assembled all available in-river PCB concentration and flow data (in order to calculate PCB mass loading) and all available PCB concentration and flow data from known dischargers and tributaries (see summary tables in Attachment 4). These data include measurements from both low-flow and high-flow conditions. The 2014 sampling event covers most of the major in-river sampling locations as well as most of the major identified dischargers. Despite the lack of synoptic data during high-flow periods, when high precipitation is influencing runoff, river flow, and the discharger flows, the sampling collected to date is adequate for determining the main sources of PCBs to the river and the main types of PCB applications that contributed PCBs to the river.

[20] Based on the mean load.

Table 4.1 Summary of Discharger PCB Mass Loadings and PCB Loadings in the Spokane River Based on the 2014 Low-flow Synoptic Survey Sampling

Discharger or River Site	Location	River Mile	Mean Loading (mg/day)	Mean Loading (ounces/day)
Discharger	Coeur d'Alene WWTP	111	9	0.00032
	Post Falls WWTP	102	2	0.00007
	Liberty Lake WWTP	92.7	1	0.00004
	Kaiser Aluminum	86	131	0.00462
	Kaiser Area Groundwater	84.25	130	0.00459
	Inland Empire Paper Company	82.5	82	0.00289
	Spokane County WWTP	78	11	0.00039
	Hangman Creek	72.80	–	–
	Riverside WWTP	67.4	312	0.01101
	City of Spokane MS4	67.08	–	–
	City of Spokane CSO	66.86	–	–
	Little Spokane River	56.30	–	–
River	Lake Coeur d'Alene, ID	111	19	0.00067
	Post Falls, ID	102	34	0.00120
	Stateline	99.52	–	–
	Greenacres/Barker	90.5	14	0.00049
	Trent Bridge	84.3	373	0.01316
	Upriver Dam	80.3	–	–
	Green Street Gage	78	–	–
	Monroe Street Gage	74.8	–	–
	Spokane Gage	72.9	510	0.01799
	Nine Mile Dam	63.6	419	0.01478
	Long Lake	38.4	–	–

Notes:
CSO = Combined Sewer Overflow; MS4 = Municipal Separated Storm Sewer System; PCB = Polychlorinated Biphenyl; Riverside WWTP = Riverside Park Water Reclamation Facility; WWTP = Wastewater Treatment Plant.
"–" = PCB loading was not calculated at these dischargers or these river stations during the 2014 synoptic survey.

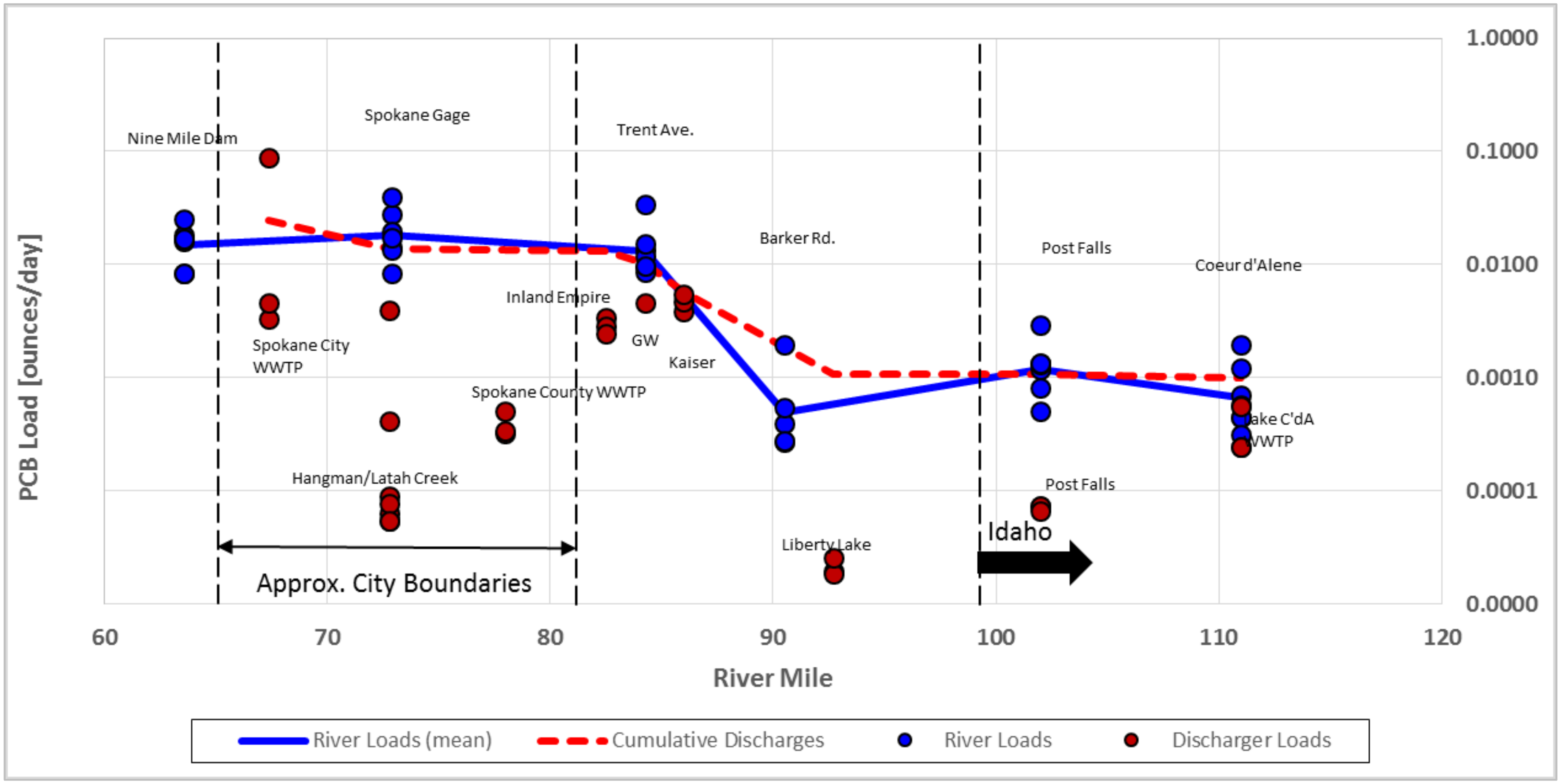


Chart 4.1 Spokane River Mass Loading, Low Flows Only (2014 Synoptic Survey). The City of Spokane is located between River Mile 63 and River Mile 81.

4.2 PCB levels in the Spokane River are below regulatory levels.

4.2.1 PCB levels in the Spokane River are below the Washington State and US EPA water quality criteria.

PCB loading to the Spokane River is low enough that the river water meets both the Washington State Water Quality Standard for total PCBs (170 ppq) (WA Ecology, 2019a) and the US EPA National Primary Drinking Water Regulation for PCBs (500 ppq) (US EPA, 2018b). In its 2016 Comprehensive Plan, the Task Force, of which the City of Spokane is a member, concluded that the Spokane River complied with the US EPA-approved Washington State Water Quality Standard for total PCBs (WA Ecology, 2019a): "[a]verage concentrations at all stations show compliance with the current Washington State Water Quality Standard of 170 pg/L [170 ppq]" (LimnoTech, 2016a). The conclusion presented in the Task Force's "2016 Comprehensive Plan to Reduce Polychlorinated Biphenyls (PCBs) in the Spokane River" was based on the approximately 5 years of studies and meetings conducted by the Task Force since its creation in 2012 (LimnoTech, 2016a).

Table 4.2 and Chart 4.2 show the results from the Task Force's "2016 Comprehensive Plan to Reduce Polychlorinated Biphenyls (PCBs) in the Spokane River," which documents the recent sampling of the Spokane River water and shows that the average concentration <u>at every station</u> that was sampled is below the State Water Quality Standard of 170 ppq. In follow-up Spokane River sampling in 2018, all PCB concentrations in the Spokane River were below the 170 ppq State Water Quality Standard (LimnoTech, 2019a). These data points are also provided in Table 4.2 and Chart 4.2. See also Figure 5.

Table 4.2 Summary of Task Force-measured Spokane River Water Column PCB Concentrations

River Sampling Location	PCB Concentration	
	Arithmetic Mean (ppq)	Geometric Mean (ppq)
Lake Coeur d'Alene (SR-15)		
2014 to 2016 Sampling	17	14
2018 Sampling	N/A	N/A
Post Falls (SR-12)		
2014 to 2016 Sampling	21	18
2018 Sampling	N/A	N/A
Greenacres/Barker Rd. (SR-9)		
2014 to 2016 Sampling	24	14
2018 Sampling	70	66
Mirabeau Point (SR-8a)		
2014 to 2016 Sampling	37	18
2018 Sampling	110	62
Trent Bridge/Plante's Ferry (SR-7)		
2014 to 2016 Sampling	133	107
2018 Sampling	150	144
Greene Street Bridge (SR-4)		
2014 to 2016 Sampling	118	105
2018 Sampling	107	106
Spokane Gage (SR-3)		
2014 to 2016 Sampling	154	131
2018 Sampling	121	121
Nine Mile Dam (SR-1)		
2014 to 2016 Sampling	144	132
2018 Sampling	129	129

Notes:
N/A = Not Available; PCB = Polychlorinated Biphenyl; ppq = Parts Per Quadrillion; Task Force = Spokane River Regional Toxics Task Force.
2014 to 2016 data from Table 1 in LimnoTech (2016a). 2018 data from LimnoTech (2019b).

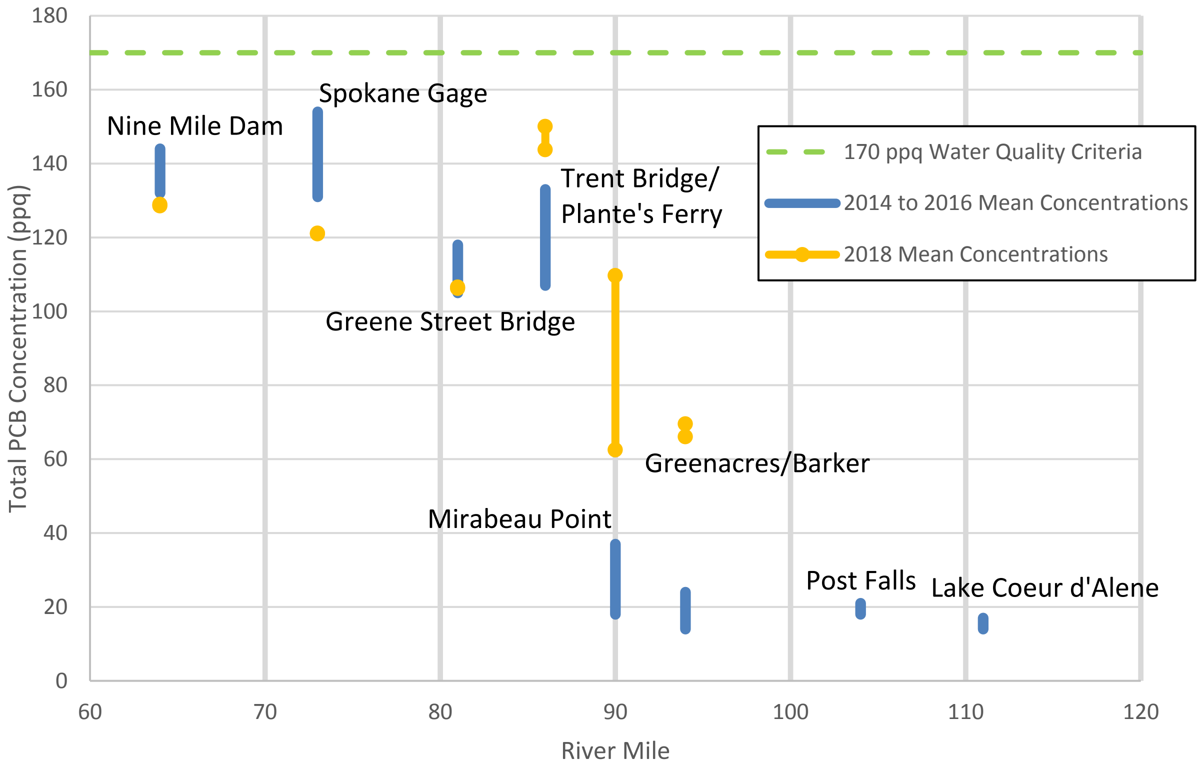


Chart 4.2 Mean PCB Concentration at Each River Station Reported in Table 4.2. The geometric and arithmetic mean PCB concentrations at each station are connected with a blue marker for 2014-2016 data and with an orange marker for 2018 data. The 170 ppq Washington State Water Quality Standard (WA Ecology, 2019a) for total PCBs in shown with the dashed green line. The 2018 data have not been blank corrected, which would reduce the concentrations shown on this graph.

4.2.2 The vast majority of Spokane River sediments are not impacted by PCBs.

As discussed in Section 1, there is a limited supply of fine sediments in the river and the only locations where fine sediments have accumulated are in the impoundments behind the dams. The only sediment remediation activities that I am aware of took place at the Upriver Dam and Donkey Island, where soils were removed from Donkey Island and sediments behind the dam were capped starting in 2006 (WA Ecology, 2015a). The sources of PCBs to this site included known industrial users and dischargers along the river corridor, including Spokane Industrial Park, Kaiser Trentwood Works, Liberty Lake Sewage Treatment Plant, and IEP (WA Ecology, 2015a).

Sediment sampling results throughout the river show that even by conservatively comparing the sampling location maxima to the Washington State PCB sediment cleanup goal (WA Ecology, 2019b), the vast majority of sediments in the river are below this criterion (Figure 6). A more realistic comparison to Washington State sediment PCB cleanup goals would be with reach-averaged PCB concentrations, which would also be below the Washington State criterion.

4.3 The amount of metals and raw sewage discharged to the Spokane River vastly outweighs the low levels of PCBs.

The USGS has calculated that large amounts of heavy metals such as zinc, lead, and cadmium are released to the Spokane River watershed from mining activities in the Idaho portion of the watershed. From 2009 to 2013, the USGS estimated that approximately 700,000 lbs of zinc, 36,000 lbs of lead, and 3,000 lbs of cadmium were discharged annually from Lake Coeur d'Alene into the Spokane River (Clark and Mebane, 2014). These annual average discharges of heavy metals into the Spokane River have not significantly declined over time. Prior estimates from the USGS for the years 1999 and 2000 were that 980,000 lbs of zinc, 44,000 lbs of lead, and 4,600 lbs of cadmium were discharged from Lake Coeur d'Alene into the Spokane River (USGS, 2003), meaning that the masses of these metals in the river were relatively stable over the 14-year period for which data were available. USGS also calculated that more than 105,000 lbs of total phosphorus was discharged from Lake Coeur d'Alene into the Spokane River each year (Clark and Mebane, 2014).

In addition to metals in the river, tens of millions of gallons of untreated wastewater and raw sewage are released to the river every year. The City's records of its CSO discharges to the Spokane River from the 1990s up until the present day show that, for every year that records are available, the City has released tens of millions of gallons of untreated wastewater and raw sewage directly into the Spokane River (Spokane, Washington, 1999-2017). For example, in 2017, there were 144 CSO discharge events that discharged a combined 71,000,000 gallons of untreated wastewater and raw sewage into the Spokane River (Spokane, Washington, 2019). In 2018, annual precipitation was much lower, yet the City still discharged 41,000,000 gallons of untreated wastewater and raw sewage into the Spokane River (SWWM, 2019). Studies in the Spokane River have shown that these discharges cause a rise in fecal coliform in the river that can persist for multiple weeks after each event (Spokane, Washington, 1977). The City is aware of the health risks posed by fecal coliform in the river, which include cholera, typhoid fever, tuberculosis, dysentery, and hepatitis (Hendron, 2019, p. 156; Soltero *et al*., 1990).

As opposed to the heavy metals, raw sewage, and other substances that are discharged at large volumes to the Spokane River every year, PCB loading to the Spokane River is small enough that the river water meets both the Washington State Water Quality standard for total PCBs (170 ppq) (WA Ecology, 2019a) and the US EPA National Primary Drinking Water Regulation for PCBs (500 ppq) (US EPA, 2018b). On a mass basis, the Plaintiff's expert Dr. Dilks has cited Task Force work that shows approximately 1.475 grams of PCBs per day flow through the river (Dilks, 2019). This is equal to 1.18 lbs of PCBs per year, which is miniscule when compared to the hundreds of thousands of lbs of heavy metals that are discharged from mining operations into the river each year that make it into Washington State and the tens of millions of gallons of untreated wastewater and raw sewage that the City discharges into the river every year.

Note that throughout this report, I present PCB loads in the river and loads from various dischargers in units of mg/day in order to facilitate comparison between the values reported here and previous studies by the Task Force, the City, and the City's experts, all of whom used units of mg/day as well. There are 454,000 mg in 1 lb; conversely, 1 mg is equal to 0.000002205 lbs.

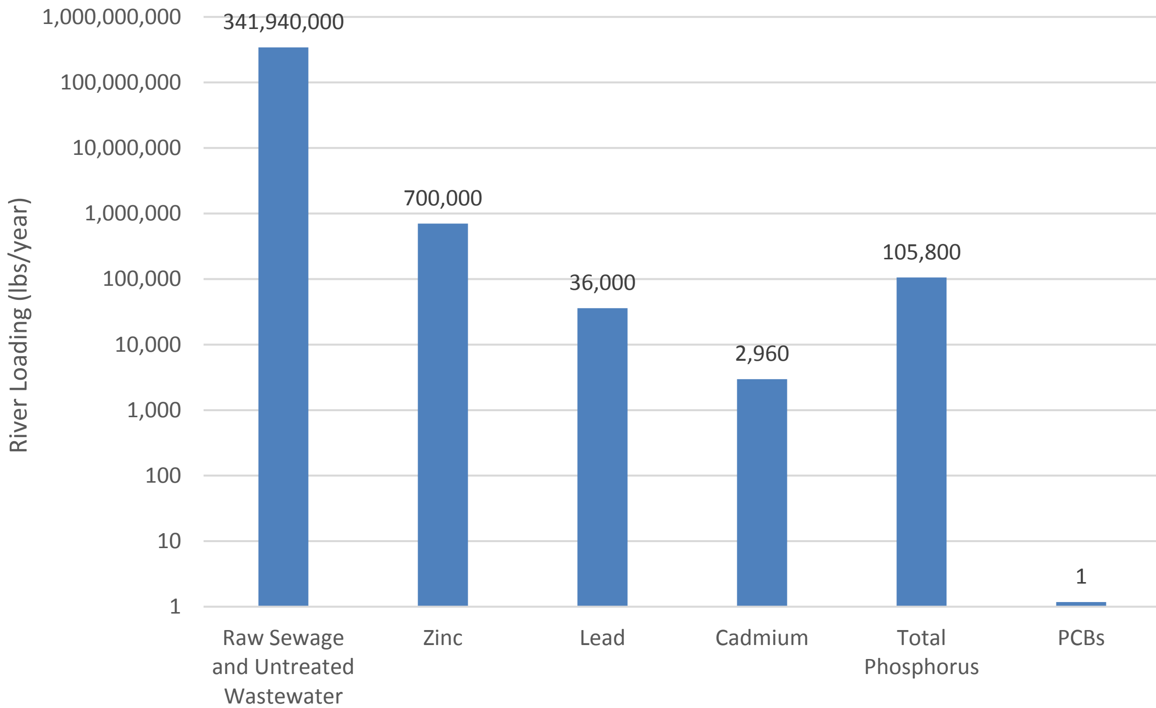


Chart 4.3 Annual River Loading of Sewage, Metals, Phosphorus, and Total PCBs to the Spokane River. The loadings of sewage, three commonly reported metals, phosphorus, and PCBs are plotted on log-scale to facilitate comparison between the several orders of magnitude difference between the amounts of metals and sewage and the relatively small amounts of PCBs in the river each year. The mass load of raw sewage and untreated wastewater was calculated using a density of 8.34 lbs/gallon and the discharge volume reported in SWWM (2019).

The large quantities of metals discharged to the Spokane River every year result in exceedances of the Washington State Water Quality Standards for metals in surface water (WA Ecology, 2019a). Charts 4.4 and 4.5 show the lead and zinc concentrations in the river compared to the State Water Quality standards for each individual metal. Both lead and zinc exceed their respective State Water Quality Standard at the few locations they were sampled for near the City of Spokane.

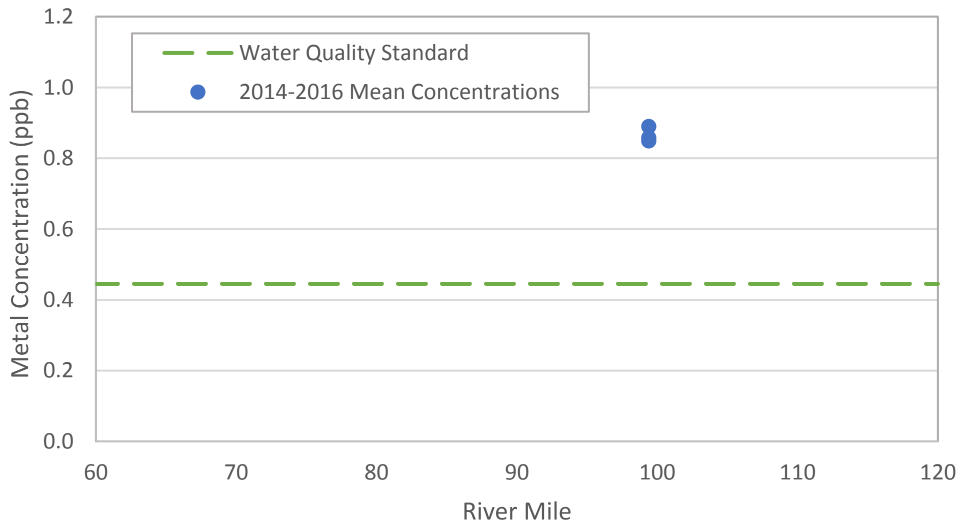


Chart 4.4 Mean Lead Concentration at Each River Station for Which Data Were Reported for Recent Years. The annual mean lead concentrations at each station are shown with a blue marker for all data (only 2014-2016 data was found to be available). The Washington State Water Quality Standard for lead is based on total hardness in the water. The average water hardness from the Stateline station near River Mile 99 was calculated for data from 2014-2016 to be 21.04 ppm (WA Ecology, 2019c). Based on this hardness value, which remained nearly constant over the 2 years of records, the State Water Quality Standard for lead is 0.45 ppb, using the formula provided by WA Ecology (2019a).

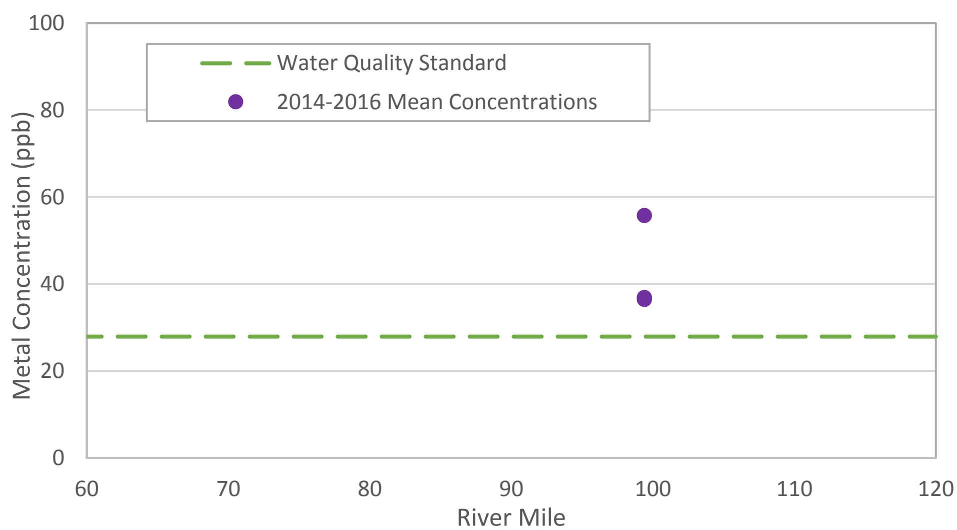


Chart 4.5 Mean Zinc Concentration at Each River Station for Which Data Were Reported for Recent Years. The annual mean zinc concentrations at each station are shown with a blue marker for all data (only 2014-2016 data was found to be available). The Washington State Water Quality Standard for zinc is based on total hardness in the water. The average water hardness from the Stateline station near River Mile 99 was calculated for data from 2014-2016 to be 21.04 ppm (WA Ecology, 2019c). Based on this hardness value, which remained nearly constant over the 2 years of records, the State Water Quality Standard for zinc is 27.9 ppb, using the formula provided by WA Ecology (2019a).

4.4 Environmental levels of PCBs have been declining over time.

Temporal trend studies from the US as well as around the world reveal that PCB concentrations in environmental media have declined since the 1970s in response to the decline in global product PCB manufacturing and declining releases. Due to continuing emission reductions (Breivik *et al*., 2007) and *in situ* environmental degradation processes (Paasivirta and Sinkkonen, 2009), PCB concentrations are expected to continue declining.

While global concentration trends show a consistent PCB decline, two exceptions are noteworthy:

- First, most countries stopped producing PCBs by the mid-1980s; however, byproduct PCBs are still inadvertently generated in appreciable quantities by many industrial processes involving high temperatures, carbon, and chlorine. See Section 2 and Attachment 3 for discussion of byproduct PCBs and their sources. WA Ecology states that byproduct PCB production is actually likely increasing, in direct contrast with legacy product PCBs, which are decreasing in the environment (Borgias, 2014).
- Second, PCBs remain at sites that have not been fully addressed (*e.g.*, the Kaiser Aluminum site in the Spokane River watershed, which is in the process of being cleaned up) and in regions accepting large quantities of electronic waste (e-waste) from the developed world (Jaward *et al*., 2004; Li *et al*., 2010).

4.4.1 Global Trends in Emissions

PCB emissions declined in response to the cessation of product PCB manufacturing. Reductions were gradual rather than immediate, because the US regulations mandating that manufactures cease production of open PCB use systems did not require the disposal of PCB-containing items that were already in use (US EPA, 1979). Breivik *et al*. (2007) estimated that 13-17% of historically produced PCBs were still in use in 2007.

Byproduct PCBs were not affected by the cessation of product PCBs manufacturing, and emissions from byproduct PCB-containing materials and byproduct PCB-generating processes may be significant. Assessments by Cui *et al*. (2013) and Song *et al*. (2018) suggest that byproduct PCB emissions from steel and cement production in China may now exceed emissions from intentionally produced PCBs. Rodenburg *et al*. (2010) and Guo *et al*. (2014) estimated that emissions of PCB 11 (a byproduct PCB congener associated with yellow pigments and dyes) from ordinary household goods are now large enough on their own to prevent the Delaware River watershed from meeting its TMDL requirements.

4.4.2 PCB Degradation Processes

PCBs released into the environment undergo degradation, unlike inorganic chemicals such as metals. The two degradation processes of greatest relevance for PCBs are photodegradation (*i.e*., degradation by sunlight) and biodegradation (*i.e*., degradation by micro-organisms) (Abramowicz, 1990; Sinkkonen and Paasivirta, 2000; Paasivirta and Sinkkonen, 2009). Photodegradation occurs in the atmosphere, the upper depths of surface waters (approximately the top 2 m), and the upper depths of soils and sediments (approximately the top millimeter). Photodegradation rates are a function of temperature, the photo-oxidant concentration (in which the primary photo-oxidants are hydroxyl radicals), and the sorption behavior of the PCB, or its relative occurrence on atmospheric particles *versus* air (Sinkkonen and Paasivirta, 2000).

Biodegradation occurs in both aerobic (oxygen-rich) and anaerobic (oxygen-depleted) soils and sediments (Abramowicz, 1990). The rate of biodegradation is a function of temperature and many other environmental properties, including the microbial community and the soil moisture content (Sinkkonen and Paasivirta, 2000). Dechlorination has also been observed to occur in sewers (Capozzi *et al*., 2019).

Metals in the Spokane River, such as lead, zinc, and cadmium, which routinely exceed their respective Washington State Water Quality Standards (WA Ecology, 2019a), cannot degrade. Unlike PCB molecules, molecules of metals found in the environment cannot break down into different chemicals.

Table 4.3 lists the estimated range of degradation half-lives (photodegradation + biodegradation) of PCBs by number of chlorine atoms in air and soil/sediment, where the half-life is defined as the time it takes for half of the PCB mass to degrade. As shown in Table 4.3, rates of PCB degradation and intermedia transfer are strongly congener-dependent, with lighter congeners degrading more rapidly than heavier congeners.

Table 4.3 PCB Degradation Half-lives by Number of Chlorine Atoms in Air and Soil/Sediment

Homolog (nCl)	Congener Number Range	Air		Soil/Sediment	
		Min. (Days)	Max. (Days)	Min. (Years)	Max. (Years)
1	1-3	4.2	13	0.57	2.3
2	4-15	4.2	13	0.80	2.7
3	16-39	13	42	1.1	4.1
4	40-81	42	130	1.7	5.5
5	82-127	42	130	2.3	9.1
6	128-169	130	400	2.9	11
7	170-193	130	400	3.4	13
8	194-205	400	1,200	4.0	14
9	206-208	400	1,200	4.6	17
10	209	2,100	2,100	6.8	21

Notes:
nCl = Number of Chlorine Atoms; PCB = Polychlorinated Biphenyl.
Adapted from Paasivirta and Sinkkonen (2009, Table 1), citing values from Mackay *et al*. (1992, Table 4.5).

4.4.3 PCB concentrations have declined in the Spokane River environment.

Sediment records from Spokane demonstrate a long-term decline in PCB concentrations since the 1970s (Chart 4.6), despite a lack of PCB-specific cleanup efforts in the river.[21]

Sediment deposits in Lake Spokane (the body of water, also known as Long Lake, that was formed by Long Lake Dam on the Spokane River downstream from the City of Spokane) show declining PCB concentrations since the 1970s (WA Ecology, 2011a). Sediments in both Upper and Lower Lake Spokane have been analyzed for PCBs. Concentrations in Upper Lake Spokane sediments peaked near 1967 and declined steadily through the most recent measurements, dated to 2003. The Lower Lake Spokane sediments' PCB concentrations peaked near 1959 and declined steadily through 2003, and are likely to continue to decline due to the flushing of sediments and degradation of PCBs in the sediments. The WA Ecology study suggested that "PCB concentrations at the sediment surface will decrease by one-half

[21] The only PCB-specific cleanup along the river to date was at the Upriver Dam and Donkey Island site. This site underwent remediation between 1999, when the site was identified, and 2007, when construction was complete (WA Ecology, 2015a). Sediments behind Upriver Dam were capped and soils on Donkey Island were excavated.

approximately every ten years in upper Lake Spokane" (WA Ecology, 2011a), predicting a continued decline in PCB concentrations in the environment. This half-life is generally consistent with the range reported in the scientific literature (see Table 4.3).

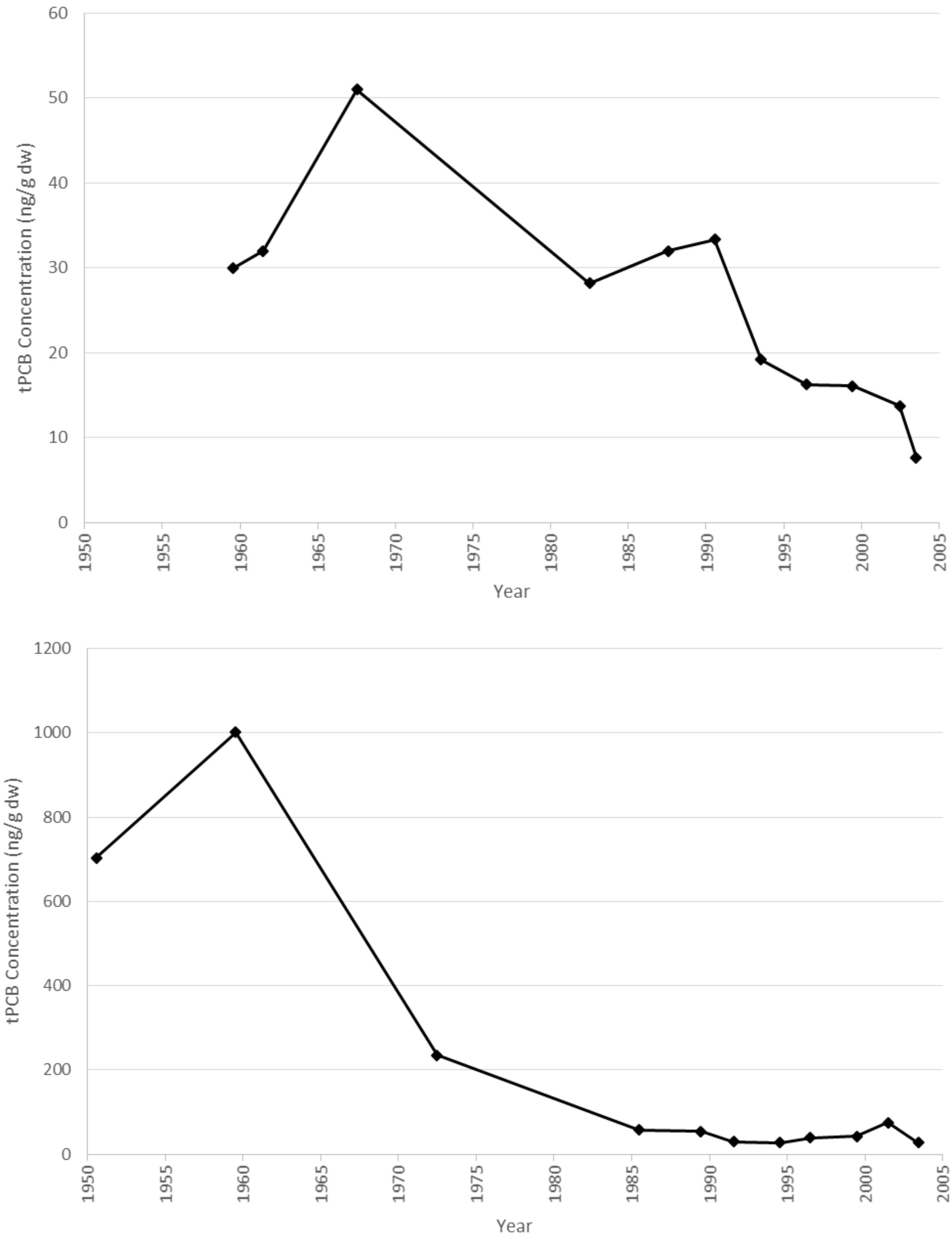


Chart 4.6 Temporal Trend in Age-dated PCB Concentrations in Sediment Cores, Upper Lake Spokane (Upper Panel) and Lower Lake Spokane (Lower Panel). dw = Dry Weight; tPCB = Total Polychlorinated Biphenyls. Adapted from WA Ecology (2011a).

5 The City of Spokane's actions demonstrate that PCBs in the river are not a problem.

5.1 The City continues to knowingly buy and use PCB-containing products that are released into the environment.

In 2015, the City of Spokane studied the presence of byproduct PCBs in municipal products purchased and used by the City on a regular basis (SWWM, 2015c; Spokane, Washington, 2016). Byproduct PCBs were detected in every product selected for analysis by the City (except for two samples) at concentrations ranging up to 2.5 ppm. The City found byproduct PCBs in its traffic paints, road marking materials, deicers, soaps, pesticides and herbicides, oils and gasolines, dust suppressants, pavement repair materials, landscaping materials, pipes, antifreezes, as well as personal care products (Table 5.1). Many of the products used by the City are used in an uncontained manner and can wash off into sewers and into the Spokane River.

The City of Spokane continues to routinely purchase and use many PCB-containing products, including a large number of products that are used in a manner that results in releases of PCBs to the environment. The PCB presence in these products is overwhelmingly due to byproduct PCBs, which are present in a large number of pigments and dyes that end up in a wide variety of products. The City of Spokane passed a "PCB Purchasing Ordinance" in June 2014 that required City departments to look for alternative products that do not contain PCBs, but only if feasible and if the increased cost for the replacement products is within 25% of the price of the PCB-containing products (SWWM, 2015b; LimnoTech, 2016a). Despite this ordinance, the City continues to purchase and use PCB-containing products, a practice that results in PCB loading to the Spokane River. Numerous studies, conducted both before and after the City ordinance was passed, have been performed by the City, the Task Force, and WA Ecology, documenting the presence of PCBs in these products. The City acknowledged that the vendors of products it purchases often do not have the PCB sampling information that the City requests (Feist, 2019, pp. 591-592). The City also admits that the ordinance is not actively enforced and that the City does not require vendors to sample products for PCBs (Feist, 2019, pp. 591-592, 594-595). The State of Washington also has a PCB-free purchasing policy for State agencies subject to the same caveats as the City ordinance (Washington State Legislature, 2014; LimnoTech, 2016a).

Table 5.1 PCB-containing Products Purchased and Used by the City of Spokane

Category	Sub-category	Studies
Roadway Deicer and Traction Products	MgCl	SWWM (2015c)
	MgCl	Spokane, Washington (2016)
	Road Sand	Spokane, Washington (2016)
	CaCl	Spokane, Washington (2016)
	Road Salt	Spokane, Washington (2016)
Traffic Paint	Yellow Paint	SWWM (2015c)
	White Paint	SWWM (2015c)
Pavement Repair	Asphalt	SWWM (2015c)
	Crack Sealant	SWWM (2015c)
Pesticides	N/A	SWWM (2015c)
Vehicle Wash Soap	N/A	SWWM (2015c)
Hydroseed	N/A	SWWM (2015c); SRRTTF (2015); WA Ecology (2016a)
Antifreeze	N/A	SWWM (2015c)
Motor Oil	N/A	SWWM (2015c)
Dust Suppressant	N/A	SWWM (2015c)
Fire Fighting Foam	N/A	SWWM (2015c)
Silicones	N/A	SWWM (2015c)
PVC and Pipe Materials	N/A	SWWM (2015c)
Fuel Additive	N/A	SWWM (2015c)
Personal Care Products	N/A	SWWM (2015c)
Flame Retardants	N/A	SWWM (2015c)
Cleaners and Degreasers	N/A	SWWM (2015c)

Notes:
CaCl = Calcium Chloride; MgCl = Magnesium Chloride; N/A = Not Applicable; PCB = Polychlorinated Biphenyl.

Many of the PCB-containing products listed in Table 5.1 are applied directly to outdoor surfaces and are not collected or recycled after use. In other words, approximately 100% of the applied volume of many of these products, including the PCBs present in the products, is released to the environment within the Spokane River watershed. The City has acknowledged that its continued purchase and use of many of these products mean that byproduct PCBs can be introduced into stormwater (Hendron, 2019, pp. 322-323).

Traffic paint is applied directly into the environment (*i.e.*, roadways) and not recovered or removed after it is applied, similar to how pesticides and hydroseed are directly applied to soil and vegetation. The City repaints the majority of its arterial roads between April and October (Spokane, Washington, 2018). It is therefore safe to assume that all traffic paint – and thus, all PCBs in traffic paint – escapes into the watershed within, at most, a few years of application. Because of the use of the products in which they are contained,

it has been estimated that all byproduct PCBs are ultimately released to the environment (Davies and Delistraty, 2016).

The combination of the City of Spokane's continued use of large numbers of PCB-containing products and the application of these products in an unrecovered manner directly into the environment represents a significant ongoing load of PCBs to the Spokane River watershed. Despite the "PCB Purchasing Ordinance" enacted by the City and despite numerous City-led studies and studies by other parties, the City continues to knowingly purchase these PCB-containing products and to apply them directly into the environment.

5.2 The City continues to spread PCB-containing solid waste onto farmland, knowing that some of those PCBs may end up in the river.

Solids that are removed from wastewater during treatment at the Riverside WWTP are dewatered to form a sludge-like material referred to as "biosolids." These biosolids from the Riverside WWTP are recycled for use as an agricultural fertilizer and applied to agricultural land near the City of Spokane (Windsor, 2019, p. 77), including at least two locations within the Spokane River watershed (Chart 5.1; HDR Engineering, Inc., 2009; HDR, Inc., 2010; Spokane, Washington, 2017b). These biosolids contain PCBs and when applied to agricultural land, these PCBs have the potential to run off with precipitation and increase the PCB load in the Spokane River watershed.

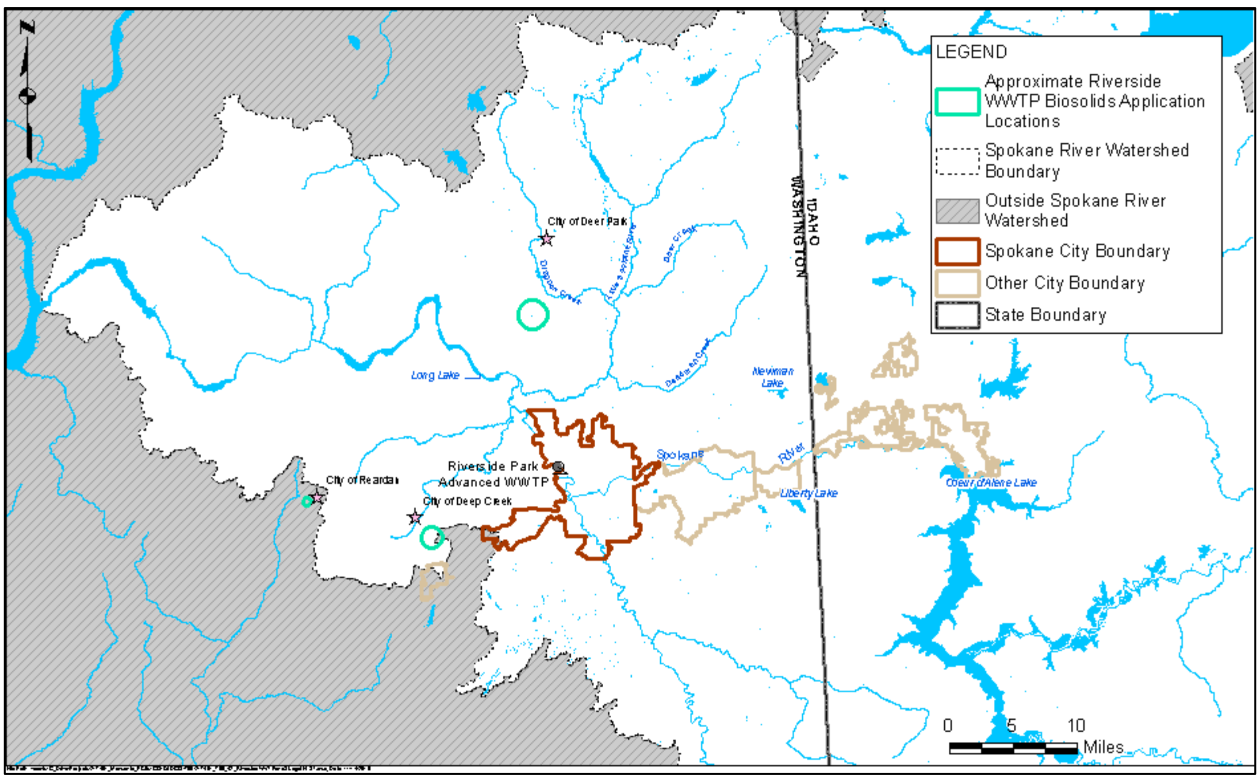


Chart 5.1 Riverside WWTP Biosolids Application Locations in and near the Spokane River Watershed.
Sources: HDR Engineering, Inc. (2009); HDR, Inc. (2010); Spokane, Washington (2017b).

PCB concentration data in the biosolids are available from as early as 1994, but the data are not publicly available for every year despite requirements in the Riverside WWTP NPDES permit to sample the biosolids annually (WA Ecology, 2016b). Publicly available biosolids sampling data are summarized in Table 5.2, ranging from 82 to 510 ppb, with 296 ppb as the midpoint of the range. PCBs were detected in every sample, yet these biosolids were still applied onto agricultural land.

Table 5.2 PCB Sampling Results for Riverside WWTP Biosolids

Sample Date	Total PCBs (Average) (ppb)	n	Information Source
8/2/1994	510	1	WA Ecology (1995)
5/2/2001	195[a]	1	WA Ecology (2002)
5/2/2001	283[a]	1	WA Ecology (2002)
2011	179	1	Donovan (2012)
2012	92-164 (134J)	3	Donovan (2013)
2013	82-129 (113J)	3	Donovan (2014)
2014	92-118 (103)	3	Donovan (2015)

Notes:
PCB = Polychlorinated Biphenyl; Riverside WWTP = Riverside Park Water Reclamation Facility; WWTP = Wastewater Treatment Plant.
J = Estimated value.
(a) Estimated value.

5.3 The City has failed to prevent others from using and discharging PCBs.

The City permits several significant industrial users (SIUs) to discharge waste directly to the Riverside WWTP or to the Spokane County WWTP, which discharges excess flows to the Riverside WWTP. A total of 31 unique SIU sites have been identified; 14 are listed in the Riverside WWTP NPDES permit, 8 are listed in the Spokane County NPDES permit and 8 were identified by the City of Spokane from their historical records search (see Figure 7). In addition, the Spokane Industrial Park currently discharges its industrial (and sanitary) wastewater to the Riverside WWTP *via* the City of Spokane sewer system, which began in 1993 (WA Ecology, c. 1991, 1996; PTI Environmental Services, 1995). Notably, the City of Spokane does not require that these SIUs test their effluent for PCBs (it only requires testing for total toxics organics), nor does it place any limits on any potential PCB discharges by these SIUs.

Byproduct PCBs (including from City byproduct PCB uses) are discharged to the Spokane River *via* the City sewer system. Although there are limited congener-specific data on discharges from the City sewers and Riverside WWTP effluent, the data that are available indicate that a significant amount of byproduct PCBs make up the PCB load in the City of Spokane MS4[22] and Riverside WWTP effluent into the Spokane River.

The total byproduct PCB contribution from these conveyances (in the forms of both total concentration as well as percentage of the total sample) has been calculated using byproduct PCB data from the published literature. The total byproduct PCB concentration is estimated by scaling up the measured concentration of PCB 11 to total byproduct PCB concentration based on the average proportion of PCB 11 to total PCBs in pigments from various byproduct PCB studies (see Attachment 3).

[22] No congener-specific data were available for the CSO outfalls.

Tables 5.3 and 5.4 summarize the results of these calculations.

Table 5.3 Byproduct PCBs Discharged from the City of Spokane MS4 (2007)

MS4 Basin	PCB 11 (ppq)	Total Byproduct PCBs[a] (ppq)
7th	40	333
Clarke	36	297
Cochran	303	2,503
Erie (CSO)	996	8,227
Greene	62	508
Howard Br.	65	539
H Street	40	330
HWY 291	26	214
Lincoln	72	592
Mission	220	1,813
Riverton	137	1,131
Superior	160	1,322
Union	349	2,885
Washington	157	1,300

Notes:
CSO = Combined Sewer Overflow; MS4 = Municipal Separated Storm Sewer System; PCB = Polychlorinated Biphenyl; ppq = Parts Per Quadrillion; WA Ecology = Washington State Department of Ecology.
Data from Parsons (2007).
(a) Based on the mean proportion of PCB 11 to total PCBs in pigments. Non-detected values are treated as zeroes. Note that byproduct PCBs are present in many more products and processes than just pigments.

Table 5.4 Byproduct PCBs Discharged from the Riverside WWTP (2014)

Effluent	PCB 11	Total Byproduct PCBs[a]
Low Concentration[b]	55 ppq	454 ppq
	5.8 mg/day[c]	48 mg/day
	0.00021 ounces/day	0.00169 ounces/day
High Concentration	57 ppq	470 ppq
	6.3 mg/day	52 mg/day
	0.00022 ounces/day	0.00183 ounces/day

Notes:
PCB = Polychlorinated Biphenyl; ppq = Parts Per Quadrillion; Riverside WWTP = Riverside Park Water Reclamation Facility.
Data from LimnoTech (2015a) and Gravity Consulting, LLC (2015).
(a) Based on the mean proportion of PCB 11 to total PCBs in pigments. Non-detected values are treated as zeroes. Note that byproduct PCBs are present in many more products and processes than just pigments.
(b) Average of two low-concentration samples.
(c) 1 mg/day is equal to 0.000002205 lb/day.

5.4 The levels of PCBs discharged from the City's MS4 do not cause exceedances of water quality criteria for PCBs in the river.

As shown in Section 4.2, PCB sampling performed by the Task Force (of which the City is a member) from 2014 to 2018 shows that the Spokane River is in compliance with the Washington State Water Quality Standard for total PCBs (WA Ecology, 2019a) in surface water, as well as the US EPA National Primary Drinking Water Regulation for PCBs (US EPA, 2018b). The PCB levels in the river, which are in compliance with the aforementioned regulations, reflect the contribution from the City's MS4 discharges as well as the permitted industrial and municipal discharges coming into the river from upstream of Spokane. In fact, the City's MS4 discharges are a small fraction of the total amount of PCBs in the river (Section 4.1). The City's expert Dr. Dilks states in his expert report that at the baseline loading rate from 2007, the Spokane River loading from upstream of the City (1,475 mg/day. equal to 0.05203 ounces/day) is more than 10 times larger than the City's MS4 discharges (129 mg/day. equal to 0.00455 ounces/day) (Dilks, 2019). In other words, the City's MS4 discharges are a very small fraction of an already small PCB load to the river that ultimately is in compliance with Washington State and US EPA regulatory criteria for PCBs in water.

5.5 City stormwater projects are general stormwater improvements, not specific to PCBs.

The City asserts that a wide range of past and future stormwater projects were "a result of discharges or releases of PCBs into the Spokane River" or are "necessary to reduce the amount of PCBs entering the Spokane River" (Office of the City Attorney, 2019, pp. 20, 40, Appendices A and C). Yet,

- According to the City, if PCBs were never invented, the City's stormwater projects in both MS4 basins and CSO basins would have had all the same design elements that they do today (Davis, 2019, Volume I, pp. 63-102). In other words, had PCBs never been invented, there are no design elements of the City's stormwater projects that would have been dispensed with (Hendron, 2019, pp. 214-215).
- The City is not subject to any discharge limits for PCBs in its MS4 stormwater permit (WA Ecology, 2019d) or in its Riverside WWTP/CSO NPDES permit (WA Ecology, 2011b).
- The vast majority of the PCB load in the river is due to sources upstream of the City. The City's contribution to the PCB load in the river from the MS4 and from CSOs is relatively minor in comparison (Section 4.1.1).
- The Spokane River, which receives the City's MS4 discharges and CSO overflows, meets the Washington State Water Quality Standard for PCBs in surface water and the US EPA National Primary Drinking Water Regulation for PCBs (see Section 4.2).
- The available stormwater PCB data are too sparse and inadequate to meaningfully inform stormwater improvement projects (Section 5.5.1).

The City does, however, have numerous regulatory requirements (including permit limits and TMDLs) to control and reduce discharges of stormwater and substances found in stormwater more broadly. For example, the City is required to control the frequency of CSO events and control discharges of various substances to the Spokane River, including CBOD, TSS, fecal coliform bacteria, pH, total residual chlorine, total ammonia, phosphorus, cadmium, lead, and zinc (Spokane, Washington, 2013; WA Ecology, 2011b, 2019d). Many of these substances are the focus of current or anticipated TMDL requirements

(CH2M HILL, 2014, p. 1-3; WA Ecology, 2010), as well as NPDES permit requirements (WA Ecology, 2011b, Section S1, 2019d, Appendix 2).

Stormwater projects listed in the damages submission (Various, 1987-2019) include projects designed to reduce CSO discharge events and stormwater discharges of multiple substances.

CSO Stormwater Projects to Reduce CSO Discharge Events – The City's CSO improvements are to address decades of regulatory orders to reduce and eliminate raw sewage discharge to the Spokane River. This regulatory history is discussed in detail in Section 5.6. Several of the City's claimed projects are similarly designed to reduce sewage overflows to the river in non-compliant CSO basins (*i.e.*, to stop discharging raw sewage to the river).

Stormwater Projects for TMDLs and Permit Compliance – Because the City is subject to TMDL and NPDES permit requirements for many substances other than PCBs, the stormwater projects in the damages submission are designed to address these substances. For example, the City is mandated to comply with TMDLs for multiple substances. One such requirement is the 2010 TMDL for DO in the Spokane River (WA Ecology, 2010). Under the DO TMDL, the City must limit stormwater discharges of phosphorus, ammonia, and CBOD (WA Ecology, 2019d, Appendix 2). For example, the Water Quality Combined Financial Assistance Agreement (WQC-2016-Spokan-00030) for the Erie and Trent stormwater project states, "[t]his project will… provide treatment for CBOD, Total Phosphorus, Ammonia Nitrogen, Cadmium, Lead, Zinc and PCBs and will also reduce flows to the Spokane River by increasing storm water infiltration" (WA Ecology, 2015b, p. 1). Notably, there is nothing "PCB-specific" about the stormwater management technologies implemented by the City (*e.g.*, grassy swales, drywells, permeable pavement); their generic design allows them address multiple substances simultaneously (Hendron, 2019, p. 214-215). Moreover, the stormwater control technologies implemented by the City were developed in the 1970s and 1980s to address pollutants other than PCBs (Davis, 2019, Volume I, pp. 63-102).

In fact, the City admitted that MS4 "improvements" were recommended by US EPA in 1979, before any PCBs were detected in City stormwater. US EPA recommendations included the same stormwater technologies used for projects in the City's current damages submission (Hendron, 2019, pp. 137-139).

5.5.1 The available stormwater PCB data are too sparse and inadequate to meaningfully inform stormwater improvement projects.

Overall, the City's stormwater PCB data are too sparse, too incomplete, and not at all targeted to the stormwater projects to meaningfully inform the design or efficacy of any improvements. The City's stormwater projects listed in the damages submission were all either implemented after 2010 or are still pending, with the majority implemented after 2014 (Office of the City Attorney, 2019). The lack of reliable data collected before the implementation of these projects, and the City's failure to identify any PCB source locations beyond the City Parcel site, means that the City does not know which sites are contributing PCBs to the stormwater basins and cannot determine what effect their stormwater upgrades have or will have on PCB levels in the river.

Between 2004 and 2014, four stormwater sampling efforts were conducted by either WA Ecology or the City of Spokane (Parsons, 2007; SWWM, 2014; WA Ecology, 2012).[23] Even after combining results across sampling campaigns, the available stormwater PCB data are sparse. Prior to 2009, for example, only four runoff events were sampled. All four events occurred in either May or June (Parsons, 2007; WA Ecology, 2011a). These data are not representative, because stormwater exhibits substantial seasonal trends. In

[23] A final technical report is available for only three out of the four sampling efforts.

addition, only three stormwater basins were sampled prior to 2007 (Mission, Superior, and Washington) (WA Ecology, 2011a). After 2011, only four were sampled (SWWM, 2014). Sampling upstream of the outfall in each stormwater basin was also limited; prior to 2009, only "end of pipe" locations were sampled (Parsons, 2007; WA Ecology, 2011a). For two out of the four sampling campaigns, flow was also not measured (WA Ecology, 2011a, p. 74, WA Ecology, 2012, p. 8). Without flows, PCB concentrations cannot be directly translated into PCB mass loads to the Spokane River.

The available PCB stormwater data also had data quality issues. For example, the authors of the 2009-2011 campaign, which was responsible for approximately 35% of the reported sample results, stated, "[s]torm events are difficult to sample…. Time to mobilize and reach manholes for sampling often forced sampling as the storm event was near the end so only one grab could be collected before flow stopped or was too shallow to collect" (WA Ecology, 2012, p. 8). The authors also noted, "[w]e had continual difficulty with clean lab blanks and field blanks. They were typically impacted with lower chlorinated congeners, including PCB-11, commonly found in inks and dyes" (WA Ecology, 2012, p. 12).

Furthermore, when the City performed MS4 improvement projects, such as permeable pavement installation, the City tested for several constituents to determine the efficacy of the pavement project, but did not test for PCBs (Davis, 2019, pp. 122-127).

5.6 City sewer upgrades are for the purposes of complying with orders to eliminate discharges of raw sewage to the river and to comply with the DO TMDL, and were planned and performed without mention of PCBs and before PCBs were detected.

The City of Spokane was settled between 1870 and 1890, prior to the installation of sewers. The first sewers were installed in 1889 (Esvelt & Saxton and Bovay Engineers, Inc., 1972). As discussed in Section 1.3, as early as 1909, the City was ordered by WADOH to cease discharging human waste to the river (Bovay Northwest, Inc., 1994). In 1929, the City was again ordered to cease sewer discharges (Bovay Northwest, Inc., 1994). In 1933, the need for a sewer system was highlighted in a City report; however, bond issues to help pay for the system were defeated in both 1933 and 1937 (Bovay Northwest, Inc., 1994).

The City passed bond issues in 1946 to build sewer interceptors to bring wastewater to the planned WWTP (Esvelt & Saxton and Bovay Engineers, Inc., 1972). The initial WWTP was finally completed in 1958; however, raw sewage continued to be discharged directly to the river during high flow events and wet weather (Bovay Northwest, Inc., 1994). In the 1960s, there were up to 45 different locations in the City of Spokane where raw sewage was discharged to the river. Some of these locations discharged raw sewage into the river up to 140 times per year (Bovay Northwest, Inc., 1994).

In 1990, before PCBs were detected in the Spokane River, the City completed the first phase of its separated storm sewers (Bovay Northwest, Inc., 1994).

In 1994, the City's CSO reduction plan was published. PCBs were specifically stated to be not detected in the river sampling discussed in this plan (Bovay Northwest, Inc., 1994). No action was taken by the City on this plan until 1999, when the City voted to adopt the plan, setting a deadline of December 2017 for completion of the plan. PCBs were not mentioned at the time this plan was adopted. The City's current NPDES permit (No. WA-002447-3) requires Spokane to achieve a 20-year moving average of no more than one overflow event per year at each CSO outfall by 2017 (WA Ecology, 2011b, Section S13.B). The City was granted an extension until December 31, 2019, to comply with this permit (Simmons, 2017; WA Ecology, 2017d). As of August 2019, the City is still not in compliance with this requirement

(SWWM, 2019). Spokane's Next Level of Treatment Plan involving new filtration technology at the Riverside WWTP is still in the pilot phase and not in full operation despite being ordered to be completed by 2017, specifically for phosphorus removal in order to comply with the phosphorus loading requirements in the City's draft NPDES permit (Spokane, Washington, 2011). Thus, the City's planned upgrades to sewers and to the WWTP are unrelated to the relatively recent detection of PCBs in the Spokane River.

6 Sources of PCBs Found in the Spokane River Watershed

Multiple studies of the Spokane River have been conducted to identify the relative significance of sources and conveyances of PCBs to the Spokane River. These studies have sampled different river media in different locations at times with different river flow conditions. These studies have also sampled individual dischargers to the Spokane River, including from industrial facilities and WWTPs, as well as from certain City conveyances (CSOs, MS4). Two main studies – the 2011 WA Ecology Spokane River PCB Source Assessment (WA Ecology, 2011a) and the "Task Force" activities leading up to the "2016 Comprehensive Plan to Reduce Polychlorinated Biphenyls (PCBs) in the Spokane River" (LimnoTech, 2016a) – have evaluated PCB mass loading to the Spokane River. Attachment 2 provides further details regarding the studies that I relied upon, as well as the data from those studies.

6.1 The sources of PCBs in the Spokane River directly confirmed by data are predominantly from fire safety product PCBs and byproduct PCBs.

As described in this section, based on a systematic evaluation of the potential sources of PCBs within the Spokane River watershed, and consistent with the findings of the PCB studies performed by WA Ecology and the Task Force, the sources of PCBs in the Spokane River directly confirmed by data or by documentation of historical releases are predominantly from fire safety product PCBs and byproduct PCB sources. These releases were not from Monsanto, which ceased production of PCBs decades ago and had no manufacturing operations in the Spokane River watershed. Attachment 4 shows the mass loading of PCBs by discharger to the Spokane River.

6.1.1 Product PCBs Sources (Closed and Semi-closed)

In this section, I discuss four of the most significant[24] product PCB sites in the Spokane River watershed: Kaiser Aluminum, GE Spokane Yard, Spokane Transformer/City Parcel, and Spokane Junkyard. At each of these sites, PCBs were released into the environment from closed or semi-closed uses by non-Monsanto entities. Attachment 5 provides further details about these and other sites where PCBs were similarly released into the environment from closed or semi-closed fire safety uses by non-Monsanto entities. These sites have either been remediated to the satisfaction of US EPA or WA Ecology or are in the process of being remediated.

Kaiser Aluminum

The Kaiser Aluminum facility is a 512-acre site located about 10 miles east of downtown Spokane (Figure 8). It is not connected to the City of Spokane's sewer system, but has a private, NPDES-permitted outfall (Outfall 001) to the Spokane River upstream of the City. PCB-containing hydraulic oils were used in the casting process at the Kaiser Aluminum facility through the late 1960s (Hart Crowser, Inc., 1991, 2012a). Hydraulic oils from this semi-closed system were released to site soils and groundwater *via* leaks

[24] Based on the work of WA Ecology, the City of Spokane, and the Task Force, as well as upon my independent research and analysis.

and spills (Hart Crowser, Inc., 2012a). PCBs were discharged to the Spokane River *via* cooling water that came into contact with hydraulic oil and subsequently discharged *via* the cooling water discharge system (Hart Crowser, Inc., 2012a). PCB transport pathways to the Spokane River include PCB-containing effluent wastewater from Kaiser Aluminum's NPDES-permitted outfall, stormwater runoff from the site (a portion of which is routed to their NPDES-permitted outfall), and groundwater plume discharge in which PCBs are present in petroleum hydrocarbon plumes[25] (*i.e.*, co-solvency resulting in PCB concentrations up to 130,000,000 parts per trillion [ppt]) (Hart Crowser, Inc., 2012a).

GE Spokane Yard

The GE Spokane Yard is an 8-acre site located within the City of Spokane (Figures 9 and 10). GE operated an industrial and utility equipment repair shop here from 1961-1980 (WA Ecology, 1984). The City of Spokane manages stormwater in this area *via* I&I (SWWM, 2015a).

PCB-containing transformer oil was spilled during transformer storage prior to repairs, transformer disassembly and cleaning, and storage of new and used transformer oils (Golder Associates Inc., 1990; see Figures 9 and 10). Potential PCB transport pathways to the Spokane River include stormwater runoff across PCB-containing soils and groundwater discharge in which PCBs are present with free-phase petroleum hydrocarbons or other carrier fluid with high PCB solvency.[26]

Spokane Transformer/City Parcel

The Spokane Transformer/City Parcel site is a 0.65-acre site located within the City of Spokane's Union MS4 basin (Figures 11 and 12). Spokane Transformer, Inc. operated an electrical transformer manufacturing, repair, and recycling facility at the site from 1961-1979 (SAIC, 2002). Spills of PCB-containing transformer oil are the primary source of PCBs that have been found at the site. WA Ecology initiated remediation activities on the City Parcel site beginning in 2009 (GeoEngineers, Inc., 2009a). In 2011, the storm drain at N. Cook and Springfield was disconnected from the Union basin stormwater system, due to this area being a suspected source of PCBs to the system (WA Ecology, 2012). Despite the fact that the City Parcel site had been remediated in 2009 to remove PCBs in soil, the Spokane Wastewater Management Department (SWWM, 2013) noted that PCB concentrations were found in the adjacent catch basin, and an overflow pipe that connected to the storm sewer system was plugged in an effort to disconnect this potential source from the river. The conclusion that City Parcel was a potential PCB contributor to the river agrees with the prior findings of the 2009-2011 Urban Waters Initiative sampling within Union basin (WA Ecology, 2012).

Two type of spills of PCB-containing transformer oil occurred at the site:

- Oils leaking from broken transformers while they were being stored outside; and
- Incidental spills of oils, which occurred while the transformers were being rebuilt, most commonly when opening an overfilled transformer or handling a transformer with a cracked casing (Myriad Systems & Services, Inc., 1990).

Potential PCB transport pathways to the Spokane River include stormwater runoff across PCB-containing soils discharged through the city sewer system. Prior to 2011, PCBs were discharged from the site *via* a storm drain to the City sewer system.

---

[25] Absent the presence of a mobile co-solvent, PCBs are not typically found in groundwater.

[26] LimnoTech concluded that there is a "strong correlation between the homolog patterns at the GE site and the homolog patterns estimated by the mass balance assessment for the Trent-Greene reach" (LimnoTech, 2018).

Spokane Junkyard

The Spokane Junkyard site is a 16-acre site located in the City of Spokane (Attachment 5; Figure 13). The Spokane Junkyard and Associated Properties Superfund site (SJA) includes the former Spokane Junkyard and the former Spokane Metals Company (SMC) facility (a scrap metal recycler) that both operated until 1983, as well as two adjoining properties known as the Carbon property and the Wall property (Attachment 5; Figure 13; Alta Geosciences, Inc., 1997). The site is within the Cochran MS4 basin; the specific conveyances from the SJA properties to the MS4 are unknown.

Spokane Junkyard received and disposed of surplus military items (such as smokestacks and boilers), automobiles, heavy equipment, appliances, drums containing organic solvents, and electrical transformers that were stored on the property (E&E, 1988); they received numerous citations from the City of Spokane (E&E, 1991). SMC, which occupied the parcel adjacent to Spokane Junkyard to the northeast, operated as a scrap metal recycling facility and purchased items from Kaiser Aluminum, Washington Water Power, and other large companies in the state; used transformers were purchased from Inland Power and Light, Coulee Dam, and the Bonneville Power Administration (E&E, 1988). Ecology and Environment, Inc. (E&E) reported that oil from used transformers was drained directly into the ground during removal of copper coils (E&E, 1991, 1998). SMC allegedly encroached onto the adjoining Wall and Carbon properties to store materials (E&E, 1991).

Potential PCB transport pathways from the Spokane Junkyard site to the Spokane River include the following: stormwater runoff across PCB-containing soils discharged into the MS4, stormwater runoff across PCB-containing soils into the river, and PCB-containing groundwater discharge.

6.1.2 Byproduct PCB Sources

6.1.2.1 Byproduct PCB Congener Data

WA Ecology, the City of Spokane, the Task Force (of which both the City and WA Ecology are members), and the City of Spokane's own consultants and experts are aware of the presence of byproduct PCBs in commonly used consumer and municipal products, as well as the presence of byproduct PCBs in the Spokane River.

Because (1) a wide variety of commercial and municipal products used in Washington State and in the City of Spokane contain byproduct PCBs, and (2) US EPA, WA Ecology, and the City of Spokane allow the continued use of products containing byproduct PCBs,[27] it is not surprising that byproduct PCBs are frequently detected in discharges to the Spokane River as well as within the Spokane River itself. This is illustrated in Chart 6.1, which summarizes the detection frequencies of multiple example byproduct PCB congeners (see Attachment 3 for further details) measured in different environmental media discharging to the Spokane River. The presence of these byproduct PCB congeners in the Spokane River and in discharges to the Spokane River shows that byproduct PCBs are actively released from byproduct PCB-containing products within the Spokane River watershed and are transported to the Spokane River, where they have been frequently detected in surface water, sediment, and fish tissue (see Figure 14 and Chart 6.2). Indeed, consultants hired by Spokane County to study PCBs in the Spokane River and PCBs present in discharges to the river considered PCB 11 (one of the most common byproduct PCBs) to be the "main problem" (Rodenburg, 2017, 2018).

[27] See Attachment 3 for background on byproduct PCBs.

Many individual byproduct PCB congeners are frequently cited in the literature as a tracer of non-legacy PCB discharges and are frequently detected in the Spokane River watershed as well, such as, but not limited to, PCBs 11, 35, 207, and 209. In fact, as discussed in Section 2, approximately 150 congeners have been identified as byproducts of other chemical processes. PCB 11 is commonly found in pigments (*e.g.*, Vorkamp, 2016 and references within), and has also been linked to silicone production and combustion (Attachment 3), but is unlikely to originate from Aroclor sources. PCB 11 was not detected above trace levels in the high-production-volume PCB Aroclors in either the Frame *et al*. (1996) or Rushneck *et al.* (2004) studies. PCB 35 is present in yellow pigments (Anezaki and Nakano, 2014) and in yellow road paint used by the City of Spokane (SWWM, 2015c; WA Ecology, 2016a). It is also only present at trace levels in some Aroclors and is commonly detected in the Spokane River watershed (Charts 6.1 and 6.2). Both PCBs 207 and 209 have been linked to pigment production, and PCB 209 was also associated with combustion and production of chlorinated chemicals (Attachment 3). Neither of these congeners were present above trace levels in high-production-volume Aroclors (see Attachment 3 for details). Additionally, PCB 209 cannot be produced from reductive dechlorination because it is a decachlorinated PCB (the highest chlorinated biphenyl). The detection frequencies of these four example byproduct PCB congeners in the various Spokane River watershed media are shown below in Charts 6.1 and 6.2.

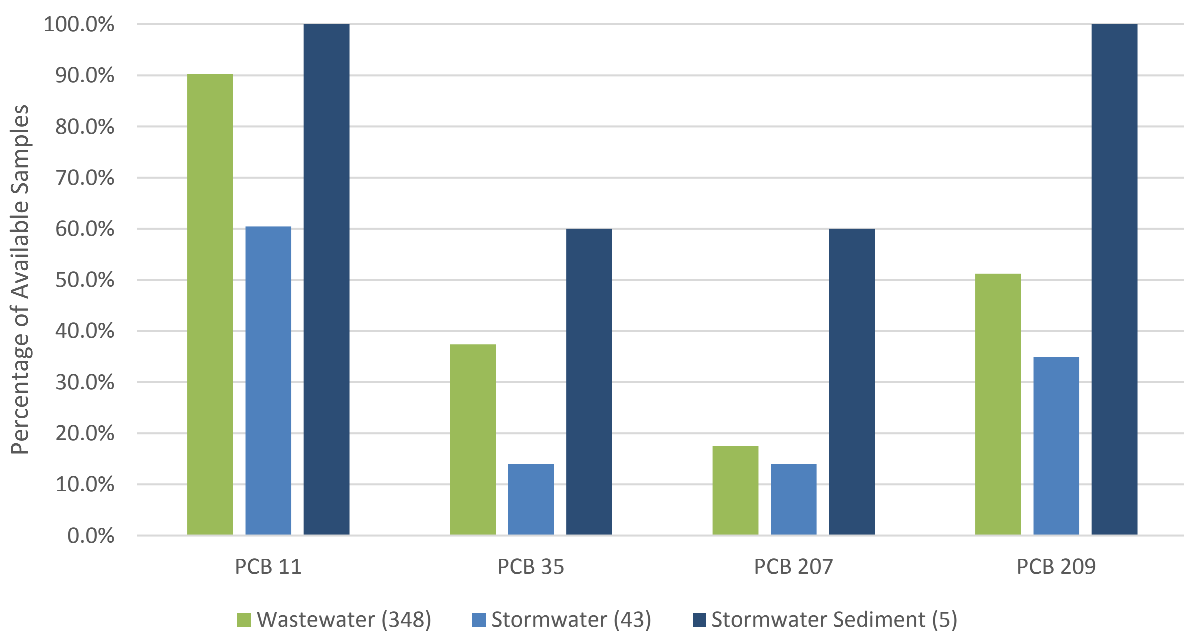


Chart 6.1 Detection Frequency of Example Byproduct PCB Congeners Detected in Discharges to the Spokane River. Data Source: See Attachment 2.

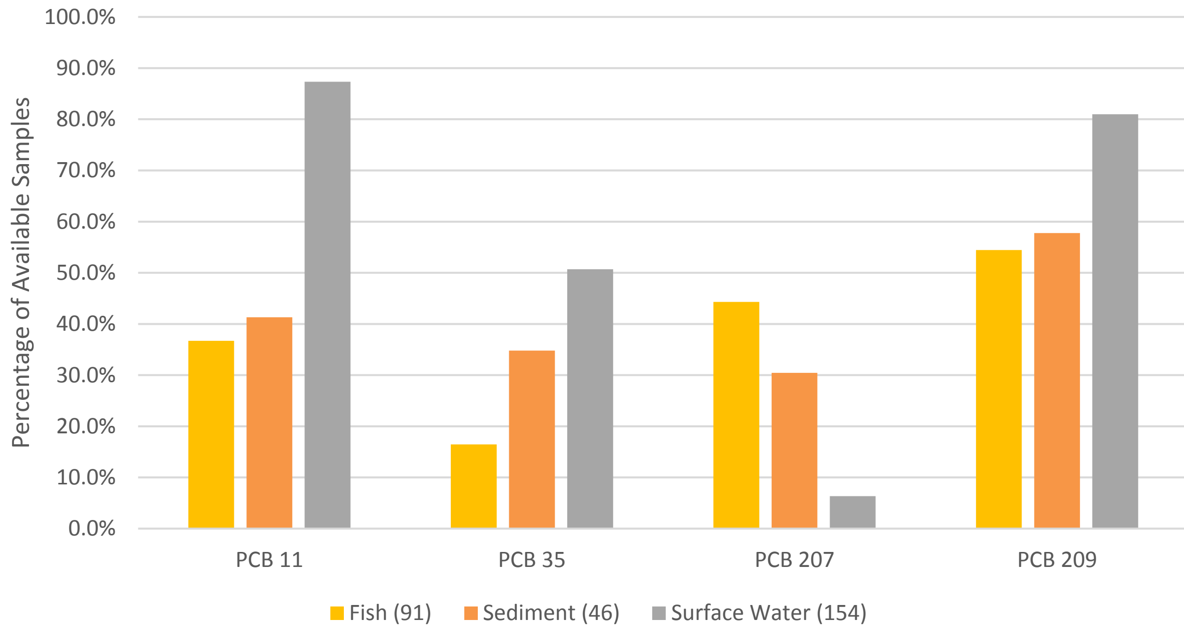


Chart 6.2 Detection Frequency of Example Byproduct PCB Congeners Detected in the Spokane River. Detection frequency calculation includes all samples except those flagged as not detected (U or UJ) or not usable (R). Data Source: See Attachment 2.

The presence of byproduct PCBs is not unique to one particular discharger or to one particular reach of the river (although IEP, as described in Section 6.1.1, is a significant source of byproduct PCBs to the river). For example, as shown on Figure 14, which shows the locations where PCB 11 was detected in surface water samples collected from the Spokane River, PCB 11 was present in nearly all the samples collected upstream of the City of Spokane (adjacent to the Liberty Lake WWTP and IEP), at various locations within the City limits, at the Hangman Creek Confluence, and downstream of the City (at Nine Mile Dam).

6.1.2.2 Byproduct PCB Loads in the Spokane River

Byproduct PCB loads in the river can be estimated by comparing byproduct PCB congener concentrations and loads to the total PCB concentration and load within the river. PCB congener concentration data were collected at multiple in-river stations by the Task Force during the 2014 and 2015 synoptic surveys as well as during the 2016 monthly sampling program (Table 6.1).

Both upstream and downstream of the City of Spokane, PCB 11 by itself makes up between 6-14% of the average total PCB load in the river (Table 6.1). In individual samples, the PCB 11 fraction of the load is much higher.

Table 6.1 Task Force Sample Locations and Byproduct PCB Sample Concentrations

Station Number	Total PCBs (mg/day)[a]				PCB 11 (mg/day)				Total Byproduct PCBs[b] (mg/day)		
	Min.	Max.	Mean	N	Min.	Max.	Mean	N	Min.	Max.	Mean
SR15	20	1200	464	5	2	115	53	5	17	950	438
SR12	91	150	127	7	6	17	11	7	50	140	91
SR9	22	111	45	15	3	13	5	15	25	107	41
SR8a	58	775	184	10	6	17	11	10	50	140	91
SR7	236	1051	393	17	9	21	14	17	74	173	116
SR4	276	525	382	10	21	58	36	10	173	479	297
SR3	318	2500	752	22	18	153	56	22	149	1264	463
SR1	350	4000	1051	18	28	363	104	18	231	2998	859
Station Number	Total PCBs (ounces/day)				PCB 11 (ounces/day)				Total Byproduct PCBs[b] (ounces/day)		
	Min.	Max.	Mean	N	Min.	Max.	Mean	N	Min.	Max.	Mean
SR15	0.00071	0.04233	0.01637	5	0.00007	0.00406	0.00187	5	0.00060	0.03351	0.01545
SR12	0.00321	0.00529	0.00448	7	0.00021	0.00060	0.00039	7	0.00176	0.00494	0.00321
SR9	0.00078	0.00392	0.00159	15	0.00011	0.00046	0.00018	15	0.00088	0.00377	0.00145
SR8a	0.00205	0.02734	0.00649	10	0.00021	0.00060	0.00039	10	0.00176	0.00494	0.00321
SR7	0.00832	0.03707	0.01386	17	0.00032	0.00074	0.00049	17	0.00261	0.00610	0.00409
SR4	0.00974	0.01852	0.01347	10	0.00074	0.00205	0.00127	10	0.00610	0.01690	0.01048
SR3	0.01122	0.08818	0.02653	22	0.00063	0.00540	0.00198	22	0.00526	0.04459	0.01633
SR1	0.01235	0.14110	0.03707	18	0.00099	0.01280	0.00367	18	0.00815	0.10575	0.03030

Notes:
PCB = Polychlorinated Biphenyl; Task Force = Spokane River Regional Toxics Task Force.
Sources: Gravity Consulting, LLC (2016); LimnoTech (2015b, 2016a,b, 2017, 2019b).
(a) 1 mg/day is equal to 0.000002205 lb/day.
(b) Based on the mean proportion of PCB 11 to total PCBs in pigments (Section 5.3). Non-detected values are treated as zeroes. Note that byproduct PCBs are present in many more products and processes than just pigments.

The total byproduct PCB load is potentially much larger than just the PCB 11 load, because PCB 11 is only a single byproduct PCB congener out of approximately 150 byproduct PCB congeners that have been identified in the published literature (Perdih and Jan, 1994; Law, 1995; Kim *et al*., 2004; Ishikawa *et al*., 2007; Hu and Hornbuckle, 2010; Anezaki and Nakano, 2013, 2015; Liu *et al*., 2013a; Anezaki *et al*., 2014; Shang *et al*., 2014; Takasuga *et al*., 2014; WA Ecology, 2014b; Huang *et al*., 2015).

6.1.2.3 IEP Discharges of Byproduct PCBs

IEP has a permit to discharge PCB-containing wastewater to the Spokane River. IEP states that all of the PCBs present in their wastewater effluent are due to the presence of byproduct PCBs in the recycled paper processed at the facility (Krapas, 2016). Indeed, PCB 11 alone makes up a significant fraction of the PCB load in IEP wastewater (Table 6.2). According to IEP, "PCB congeners associated with yellow dyes account for 20 to 40% of all PCBs in IEP's final effluent. The City's expert, Kevin Coghlan, admitted that PCB 11 is a dominant congener in IEP's final effluent (Coghlan, 2019a, pp. 237-246). The balance of PCB congeners detected in IEP's effluent have fingerprints associated with the myriad of other pigments known to include inadvertently generated PCBs" (IEP, 2016a). IEP's wastewater effluent has been sampled for PCBs numerous times between 2001 and 2017. The effluent flow rate was measured concurrently between 2001 and 2015 and remained relatively stable over the years, though it has increased from the 2001-2003 sampling to the 2014-2017 sampling.

Table 6.2 Summary of Samples of Inland Empire Paper Company's Effluent

Sample Name	Date	Source	Total PCBs[a] (ppq)	Flow Rate[b] (cfs)	Total PCB Load (mg/day)[c]	Total PCB Load (ounces/day)
188181 INLAND	5/1/2001	WA Ecology (2002)	2,436	6.7	40	0.00141
IEP02-WFE-01-A	5/6/2002	SAIC (2003)	5,488	6.9	93	0.00328
IEP02-WFE-02-A	5/6/2002	SAIC (2003)	4,568	6.9	78	0.00275
IEP_Effluent_20020605	6/5/2002	IEP (2013)	727	6.9	12	0.00042
IEP_Effluent_20020906	9/6/2002	IEP (2013)	<74	6.9	<1.3	<0.00005
3434026	10/21/2003	WA Ecology (2011a)	670	7.4	12	0.00042
4064111	2/2/2004	WA Ecology (2011a)	<619	7.4	<11	<0.00039
4188203	4/26/2004	WA Ecology (2011a)	<562	7.4	<10	<0.00035
IEP_Effluent_20100210	2/10/2010	IEP (2013)	5,975	NM	N/A	N/A
IEP_Effluent_20100630	6/30/2010	IEP (2013)	10,023	NM	N/A	N/A
IEP_Effluent_20110518	5/18/2011	IEP (2013)	10,242	*11.0*	276	0.00974
IEP_Effluent_20110714	7/14/2011	IEP (2013)	7,522	*11.0*	202	0.00713
IEP_Effluent_20111110	11/10/2011	IEP (2013)	1,301	*11.0*	35	0.00124
IEP_Effluent_20111219	12/19/2011	IEP (2013)	1,600	*11.0*	43	0.00152
IEP_Effluent_20120208	2/8/2012	IEP (2013)	1,070	*11.0*	29	0.00102
IEP_Effluent_20120411	4/11/2012	IEP (2013)	1,827	*11.0*	49	0.00173
IEP_Effluent_20120531	5/31/2012	IEP (2013)	1,570	*11.0*	42	0.00148
IEP_Effluent_20120711	7/11/2012	IEP (2013)	1,905	*11.0*	51	0.00180
IEP_Effluent_20120918	9/18/2012	IEP (2013)	5,040	*11.0*	136	0.00480
IEP_Effluent_20121106	11/6/2012	IEP (2013)	3,697	*11.0*	99	0.00349
IEP_Effluent_20130108	1/8/2013	IEP (2013)	5,511	*11.0*	148	0.00522
IEP_Effluent_20140513	5/13/2014	IEP (2016b)	3,040	*11.0*	82	0.00289
IEP_Effluent_20140827	8/27/2014	IEP (2016b)	7,140	*11.0*	192	0.00677
SR6-081314-1705	8/13/2014	LimnoTech (2015b)	4,211	11.0	113	0.00399
SR6-081914-1505	8/19/2014	LimnoTech (2015b)	3,000	11.0	81	0.00286
SR6-082114-1410	8/21/2014	LimnoTech (2015b)	2,727	11.0	73	0.00258
SR6-Composite_20140919	9/19/2014	LimnoTech (2015b)	2,785	11.0	75	0.00265
3-1	10/31/2014	IEP (2015a)	2,958	11.3	82	0.00289
3-2	11/7/2014	IEP (2015a)	3,564	11.3	98	0.00346
IEP_Effluent_20150217	2/17/2015	IEP (2016b)	1,519	*11.0*	41	0.00145
IEP_Effluent_20150424	4/24/2015	IEP (2016b)	2,567	*11.0*	69	0.00243
SR6-081815-1535	8/18/2015	LimnoTech (2016b)	4,355	11.0	117	0.00413
SR6-Composite	8/18/2015	LimnoTech (2016b)	3,764	11.0	101	0.00356

Sample Name	Date	Source	Total PCBs[a] (ppq)	Flow Rate[b] (cfs)	Total PCB Load (mg/day)[c]	Total PCB Load (ounces/day)
SR6-081815-1535_2	8/18/2015	LimnoTech (2016b)	2,841	11.0	76	0.00268
SR6-082015-1041	8/20/2015	LimnoTech (2016b)	4,450	11.0	120	0.00423
SR6-082215-1043	8/22/2015	LimnoTech (2016b)	3,125	11.0	84	0.00296
IEP_Effluent_20150828	8/28/2015	IEP (2015b)	3,277	*11.0*	88	0.00310
IEP_Effluent_20151228	12/28/2015	IEP (2016c)	3,071	*11.0*	83	0.00293
IEP_Effluent_20160111	1/11/2016	IEP (2016c)	3,254	*11.0*	88	0.00310
IEP_Effluent_20160606	6/6/2016	IEP (2016b)	4,821	*11.0*	130	0.00459
IEP_Effluent_20160829	8/29/2016	IEP (2016d)	6,674	*11.0*	180	0.00635
IEP_Effluent_20170718	7/18/2017	IEP (2017a)	1,208	*11.0*	33	0.00116
L26987-1_Final Effluent	3/14/2017	IEP (2017b)	2,631	*11.0*	71	0.00250

Notes:

cfs = Cubic Feet Per Second; IEP = Inland Empire Paper Company; PCB = Polychlorinated Biphenyl; ppq = Parts Per Quadrillion; N/A = Not Applicable; NM = Not Measured.

(a) PCB concentrations summed with U qualified results = 0. When all congeners were below the detection limit, the maximum detection limit is displayed and used in the calculation.

(b) Sources for flow measurements: WA Ecology (2002, 2011a); LimnoTech (2015b, 2016b); IEP (2015a). Flow rates shown in italics were estimated at 11 cfs based on measured effluent flow rates between 2011 and 2016 (Esvelt Environmental Engineering, 2016), which were also consistent with flow rates reported in LimnoTech (2015b, 2016b).

(c) 1 mg/day is equal to 0.000002205 lb/day.

6.1.2.4 Byproduct PCBs are still a significant source that is potentially increasing in magnitude.

The ongoing significance and potentially increasing emissions of byproduct PCBs are likely due to multiple factors. First, byproduct PCBs are produced in many different industrial processes that involve the presence of chlorine, carbon, and high temperatures (Schmidt, 2014). As such, byproduct PCBs have likely been produced for decades and continue to be produced throughout the world at amounts that are potentially increasing. Diarylide pigments have been the dominant pigments used for yellow colors in printing inks for nearly a century, and there is currently little evidence of PCB-free pigment alternatives that can match the color and transparency requirements (Christie, 2013; WA Ecology, 2014c). Additionally, byproduct PCBs were not affected by the cessation of global product PCB manufacturing (US EPA, 1984).

6.1.3 There is no evidence that landfills are a source of PCBs to the river.

There are multiple landfills within the Spokane River watershed; however, there is no evidence that any of these landfills are a source of PCBs to the river. Indeed, the City has stated that there are no PCBs entering the river from landfills in the Spokane area (Windsor, 2019, pp. 58-71). Additionally, the US EPA's Approved PCB Commercial Storage and Disposal Facilities database identifies facilities that are approved under TSCA to accept and/or dispose of PCB waste and indicates that there are no facilities currently accepting PCB-containing wastes in the Spokane River watershed (US EPA, 2019).

Furthermore, US EPA has stated that non-TSCA landfills are safe disposal sites for PCB-containing bulk waste and that those PCBs are unlikely to migrate out of the landfill to soils or groundwater:

> EPA has determined PCB bulk product waste can be safely disposed of in certain non-TSCA approved landfills (those that have been permitted, licensed, or registered by a State as a municipal or non-municipal non-hazardous waste landfill). EPA established this as a disposal option for PCB bulk product waste in its 1998 rulemaking for disposal of PCBs. Additionally, EPA evaluated the fate and transport of PCBs leaching from landfills into groundwater using EPA's peer reviewed Industrial Waste Management Evaluation Model (IWEM). This evaluation supports EPA's determination that PCB bulk product waste can be safely disposed of in certain non-TSCA approved landfills as it showed that these wastes are unlikely to migrate into groundwater or soil. (US EPA, 2017c)

The City's fact witness, Scott Windsor, stated that the City is not aware of any evidence that any PCBs in landfills in the City or surrounding Spokane County migrated out of the landfills or migrated to the Spokane River (Windsor, 2019, pp. 58-71).

6.2 Hypothetical open use contributions of PCBs to the river today are negligible at most.

A small percentage of PCBs were sold for open use applications, such as caulk, prior to 1970, and sales for these applications were voluntarily phased out by Monsanto between 1970 and 1972. Monsanto did not manufacture open use products. Rather, Monsanto sold PCBs to manufacturers who used PCBs as one out of potentially many different ingredients in proprietary product formulations. Some PCB-containing open use systems remained in use after the sales of open use systems were ceased. For a number of reasons listed below, any hypothetical contribution of PCBs from open use sources to the river today would be negligible at most.

First, PCBs in open use applications were designed to remain in those applications, and loss rates of PCBs from open uses were low. In open use applications such as caulk, PCBs functioned as a plasticizer and needed to remain in the caulk for the formulation to function as intended (Broadhurst, 1972; Erickson and Kaley, 2011). Any potential PCB losses from open use applications such as caulk would have occurred through volatilization, the process by which chemicals near the caulk surface slowly partition into the air (Little *et al*., 1994). The process of chemical volatilization from a polymer into air is a slow process that becomes slower over time. Initially, only PCBs near the caulk surface are available for volatilization. After any PCBs near the surface of the caulk are depleted, volatilization rates decline sharply (Little *et al*., 1994).

Second, only a fraction of any PCBs lost from open use applications such as caulk would make it to the Spokane River. Some PCBs would be transported in the atmosphere out of the watershed. Some PCBs would be degraded. Some would be sequestered at low concentrations in soils and other materials (Li *et al*., 2010).

Third, the PCBs that potentially volatilized from caulk had higher vapor pressure and more readily degradable congeners. As described in Section 2.1.4, PCBs as a class of compounds have a low volatility, but PCB congeners have a range of volatilities: less-chlorinated congeners have high vapor pressures than their more highly chlorinated counterparts (Li *et al*., 2010; Stemmler and Lammel, 2012). The less-chlorinated congeners have higher vapor pressures and also more readily degradable than more highly chlorinated congeners. In other words, the more recalcitrant congeners are not the congeners that are expected to be volatilized.

Fourth, PCBs that were lost from open sources such as a caulk and that ultimately potentially made it to the Spokane River would not remain in the river – these PCBs would have been flushed from the system shortly after their arrival. As discussed in Section 1.2, the Spokane River has little-to-no fine sediment retention, which is the type of sediment that PCBs typically bind with. The river is fast moving, with minimal sediment supply, meaning that sediments remain in the water column and are flushed out of the river each year during high flows in spring. Additionally, any PCB-containing open sources installed prior to the cessation of sales for these uses in 1971 would almost certainly be beyond their functional life by 2019 (nearly 50 years after the cessation of PCB sales for open use applications). These materials would likely have been removed and placed in landfills, where they are subject to environmental controls that prevent release into the environment (US EPA, 2017c).

For these reasons, the hypothetical contribution of PCBs from open use sources to the river today is negligible. PCBs sales for open uses were phased out starting in 1970, nearly 50 years ago, and the lifespan of caulk was typically 15-20 years. Of the small amount of PCBs that may have been lost from open uses, only a small fraction would potentially have made it to the river and these PCBs were the most readily degradable PCB congeners. The potential fraction of a fraction of a fraction of the PCBs in open uses that might have made it to the river would have been flushed out of the river shortly after arrival due to the lack of fine sediment deposition in the system.

Additionally, there is no Spokane River PCB data that specifically identify PCBs from open uses in the river water or sediment. The sources of PCBs in the Spokane River that are confirmed by data are from closed sources or from byproduct PCBs (see Section 6.1.1).

6.3 Fish hatcheries are an ongoing source of PCBs to the river and likely include internationally sourced PCBs.

Fish hatcheries in the Spokane River watershed are a source of PCBs to the Spokane River due to the presence of PCBs in fish feed. These PCBs in feed make it into the environment *via* two pathways: first, *via* the tissue of fish that are released from the hatcheries, and second, *via* unconsumed fish feed in the effluent water that is discharged from the hatcheries. The hatcheries of eastern Washington and northern Idaho predominately raise salmon and trout, which are scheduled for release into the wild over a range of sizes depending on the species and the receiving water body (WDFW, 2018; Idaho Fish and Game, 2017). At least six hatcheries have been identified as relevant to the Spokane River watershed: four operate within the watershed and at least two are present outside of the watershed but release fish into it (Attachment 5). Information from the Idaho hatcheries suggest that additional hatcheries in the state may supply fish to the Spokane River watershed (Idaho Fish and Game, 2017).

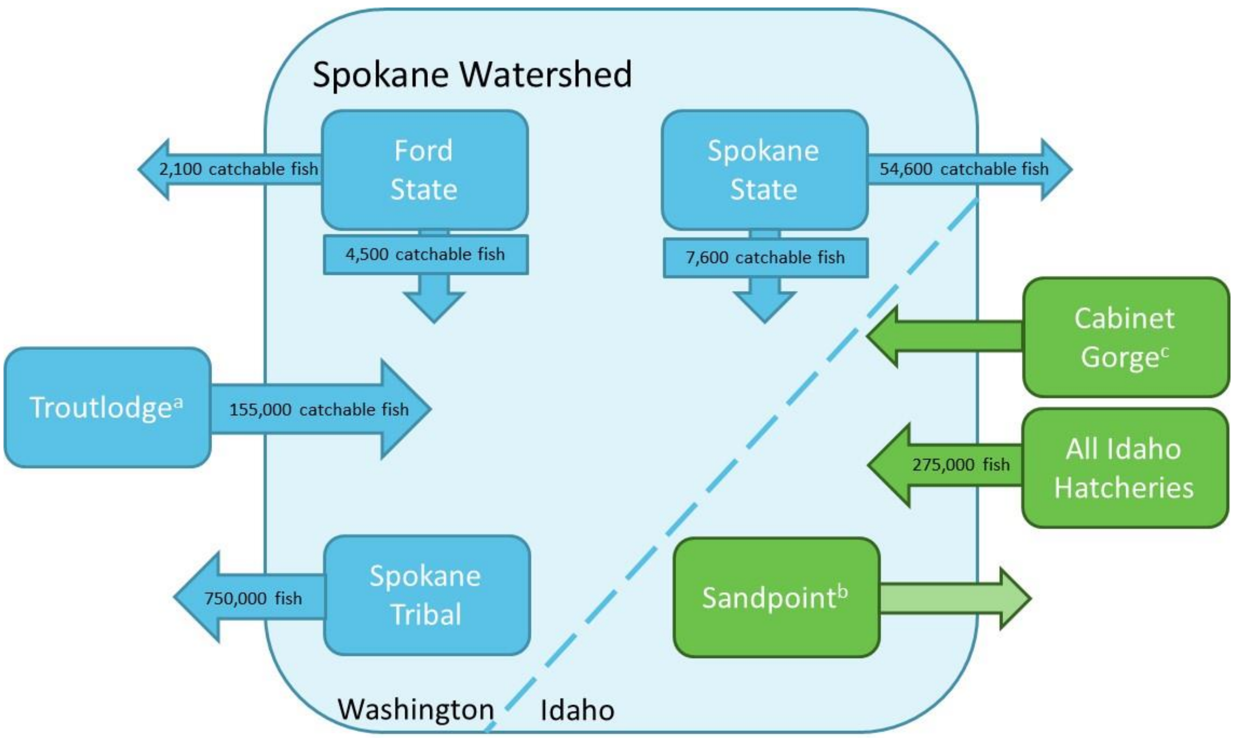


Chart 6.3 Fish Movement in the Spokane River Watershed. Hatcheries located in Washington State are shown in blue and those located in Idaho are shown in green. Notes: (a) Planned by Avista Corp. (b) No longer in operation as of 2017. (c) Individual hatchery stocking information was not located for Idaho hatcheries. Source information: WDFW (2018); IDFG (2013); WA Ecology (2016c).

PCBs have been measured in both the fish feed used at as well as the effluent of the Spokane State Fish Hatchery, located along the Little Spokane River, one of the main tributaries of the Spokane River. In a 2006 study, WA Ecology sampled fish feed and catchable trout from 10 Washington State Department of Fish and Wildlife (WDFW)-operated hatcheries throughout the state, including the Spokane State Hatchery (WA Ecology, 2006). PCBs were detected in feed from Spokane State Fish Hatchery at 16.4 ppb wet weight (ww). Overall, the average concentration of PCBs in feed from all 10 trout hatcheries was 13.8 ppb ww (WA Ecology, 2006,). WA Ecology found that PCB concentrations in fish tissue generally correlated

with concentrations in fish feed, and that fish oil was the major ingredient in the feed that contained the highest PCB concentrations (WA Ecology, 2006).

Effluent PCB concentrations were measured at the Spokane State Fish Hatchery three times in 2016 as well as in a surface water slough near its effluent discharge point (WA Ecology, 2016c, 2017f). In all three sampling events, both the effluent water and the surface water near the effluent discharge point contained PCBs.

A review of the sources of fish feed used in the US and at the Spokane watershed hatcheries indicates that PCBs in the fish feed may be from international (*i.e.*, non-Monsanto) sources. Globally, the majority of fish feed is sourced from Asia, South America, and Europe. Schipp (2008) reported that, together, these three continents were responsible for approximately 88% of total global fish feed production. Therefore, any PCBs found in fish feed from these international sources would likely be internationally sourced as well (*i.e.*, from non-Monsanto manufacturers). North America was only responsible for 7.6% of fish feed production (Schipp, 2008). These same trends have been confirmed by other studies as well. The 2008 Fishmeal Information Network (FIN) Dossier reported that Peru and Chile frequently account for over 50% of the total global supply of fish feed and fish oil, with China, Thailand, the US, and European nations making up the remaining balance (FIN, 2008). Within the US, the majority of fish feed imports reflect this global trend (Thomson, 1990). South America has historically been the main source of fish feed to the US (Thomson, 1990).

Based on the fish feed suppliers used at the Spokane State Fish Hatchery and my review of the predominant global sources of fish feed, the PCBs found in fish feed used in the Spokane watershed likely include PCBs from international (*i.e.*, non-Monsanto) manufacturers. As discussed in detail in Section 2.1.2, international product PCB formulations are typically unable to be distinguished from Monsanto Aroclors.

7 Rebuttal

7.1 Overall Rebuttal Points

I disagree with a number of assertions that appear in multiple Plaintiffs' expert reports. In this section, I discuss these points of disagreement, which apply to multiple reports. In the subsequent sections, I further detail my points of disagreement with the individual expert reports.

First, the Plaintiffs' experts fail to evaluate the significance – or even mention – other substances that impact Spokane River water quality. As discussed in detail throughout my report, the Spokane River is impacted from the ongoing discharge of large amounts of cadmium, lead, and zinc. The river is also impacted by excess phosphorus loading and has a DO TMDL program in place to address this problem. Indeed, the low levels of PCBs in the river are in compliance with the Washington State and US EPA water quality criteria for PCBs, and the City has no discharge requirements related to PCBs in WWTP effluent or stormwater discharges.

Second, the data and analyses relied upon by multiple City experts do not demonstrate a decline in PCB discharges from the City MS4. In fact, this conclusion, which was reached by the City's expert J. Michael Trapp, is fundamentally flawed, for the following reasons: inadequate data and an inappropriate analysis of the existing data. This flawed analysis and faulty conclusion that the City's MS4 load was decreasing was also relied upon by another City expert, David Dilks. My detailed explanation of how Dr. Trapp and his co-author's, Joel E. Bowdan III, analysis was fundamentally flawed is provided in the next section.

Third, the current Washington State Water Quality Standard for total PCBs in surface water in the Spokane River is 170 ppq (pg/L), and the work of the Task Force (of which the City is a member) has demonstrated that the PCB levels in the Spokane River are in compliance with this water quality criterion. The City's experts Dr. Trapp and Mr. Bowdan incorrectly stated in their report that the current Washington State Water Quality Standard for total PCBs for the Spokane River is 7 pg/L (7 ppq).

Finally, none of the Plaintiffs' experts discuss that the Spokane River is stocked with fish from outside the watershed. These stocked fish contain PCBs from fish feed, sourced at least in part from international sources.

7.2 Rebuttal to Dr. Trapp and Mr. Bowdan

Dr. Trapp and Mr. Bowdan asserted in their expert report that the City's PCB loads discharged from its MS4 system have declined since 2007 (Trapp and Bowdan, 2019). Dr. Trapp claimed to have calculated the PCB load (mg/day) discharged from the City's MS4 system in 2007 and 2018. In fact, Dr. Trapp did not do this and his conclusion is based on inadequate data and a faulty analysis.

- Dr. Trapp lacks PCB concentration data for almost all of the City's outfalls. Dr. Trapp's analysis of the discharges from the entire MS4 system (130 stormwater basins) is based on data from only 3 of the outfalls (*i.e.*, only approximately 2% of the outfalls). For the other 127 outfalls (approximately 98%), Dr. Trapp has no PCB concentration data.

- Dr. Trapp does not have PCB concentration data over time from the MS4 discharges, even for the three outfalls for which any data exist. Rather, Dr. Trapp uses a single, average concentration value that he applies to the different time periods. In other words, because Dr. Trapp uses the same PCB concentrations for both time periods, the only possible differences in PCB loading would be due to differences in stormwater discharge volumes.
- In order to calculate the PCB load (PCB Concentration × Stormwater Discharge Volume), Dr. Trapp should have used measured stormwater discharge volumes taken at the same time as measured PCB concentrations – however, Dr. Trapp did not do this, and stormwater discharge measurements are largely unavailable. Rather, Dr. Trapp estimates discharge volume in 2007 by modeling runoff for 51 years in Spokane's history, then taking the average discharge volume and applying it to 2007. For 2018, Dr. Trapp used an entirely different method to calculate stormwater discharge volume. He modeled stormwater discharge volumes using a model called WinSLAMM and admits that changing the method of estimating stormwater discharge volumes accounts for part of the observed difference (Trapp and Bowdan, 2019, p. 34). Using two different methods is essentially "comparing apples and oranges."
- In addition to using an entirely different method to calculate stormwater discharge volume in 2018, Dr. Trapp also assumed that every single MS4 project in the City was 100% effective at capturing stormwater, thus reducing the total discharge volume. Neither Dr. Trapp nor the City have data showing that stormwater discharge volumes have changed in recent years.

Essentially, Dr. Trapp makes several fundamental errors in his analysis. First, he assumes that MS4 discharge volumes have decreased because of City MS4 projects. Then, he calculates reduced PCB loads, which are entirely dependent on his faulty assumptions, because there are no PCB concentration data to support these assumptions. Finally, he concludes that the reduced PCB loads demonstrate that the City MS4 projects are effective at reducing discharge volumes and PCB loads – this is circular logic.

Furthermore, Dr. Trapp's analysis requires the assumption that PCBs are uniformly distributed throughout the City's MS4 basins, and that any City MS4 project will therefore capture PCBs. In reality, the City does not know which sites are contributing PCBs to its MS4 system and therefore has no way of knowing if any of its MS4 projects are capturing stormwater that contains any PCBs at all.

Therefore, Dr. Trapp's methodology and use of data are fatally flawed, and the opinions offered in his report are unreliable.

7.3 Rebuttal to Dr. Dilks

My main criticism of Dr. Dilks's expert report (Dilks, 2019) is his reliance on the faulty analysis and erroneous conclusion from Dr. Trapp and Mr. Bowdan that PCB loads from the City's MS4 have declined over time. Dr. Dilks led LimnoTech's report on behalf of the Task Force's "2016 Comprehensive Plan to Reduce PCBs in the Spokane River," and even in this study, Dr. Dilks and the Task Force did not make the claim that the City's PCB load from its MS4 was declining over time.

7.4 Rebuttal to Mr. Coghlan

There are several flaws in Kevin Coghlan's analysis of PCBs in the Spokane River (Coghlan, 2019b). Ultimately Mr. Coghlan's mass balance model overestimates releases of product PCBs (*e.g.*, Aroclors) at the global scale and underestimates production and releases of byproduct PCBs (*e.g.*, PCB 11); in addition,

his global mass balance model is inappropriately extrapolated from the global scale to the local scale of the City of Spokane.

In order to estimate global product PCB emissions, Mr. Coghlan relies on a global mass balance performed by Breivik *et al*. (2007). However, Mr. Coghlan ignored the actual "default" emissions estimate (1.3%) compiled in the Breivik *et al*. study and instead used a higher emissions rate (11.8%) that Breivik *et al*. presented as an arbitrary upper bound, which Breivik *et al*. calculated by simply multiplying emissions factors by 5 or 10 for various uses (Breivik *et al*., 2002). The result of ignoring Breivik *et al*.'s "default" emissions estimate is that Mr. Coghlan greatly overestimates the amount of PCBs likely emitted globally by almost a factor of 10. Furthermore, Mr. Coghlan appears to have not considered the uncertainties highlighted by Breivik *et al*. in their analysis (Breivik *et al*., 2007) and also did not consider PCB degradation over time, which is an important mechanism in the environment that reduces the prevalence of PCBs.

Mr. Coghlan also underestimates the production and releases of byproduct ("inadvertent") PCBs. Mr. Coghlan relies on out-of-date literature from the 1980s and ignores several key facts about byproduct PCB production that are relevant to their overall production volumes. First, the literature Mr. Coghlan cites from the 1980s on byproduct PCB production (US EPA, 1983; Environmental Defense Fund *et al*., 1983) surveyed a small number of companies and asked them to voluntarily report any byproduct PCB production, and was limited to only a small number of chemical manufacturing processes. Relying on self-reported estimates of byproduct PCB production from only a small number of chemical manufacturing processes underestimates byproduct PCB production for several reasons:

- Companies have an incentive to under-report production amounts, because they will be subject to additional regulations if they report PCB concentrations above 50 ppm in their processes;
- Companies may not know if byproduct PCBs are present in their processes; and
- There are other processes that have been identified in the decades since the 1980s that also have the capacity to produce byproduct PCBs in significant quantities.

Additionally, the US economy has grown since the 1980s and the number and scale of processes that produce byproduct PCBs has likely grown as well. Overall, for these reasons, Mr. Coghlan's assertion that "the total amount of PCBs inadvertently produced is less than 100,000 lbs (45,400 kg) per year in the U.S." (Coghlan, 2019b, p. 17) is likely an under-representation of the total amount of byproduct PCBs produced in this country every year.

Mr. Coghlan also inappropriately extrapolates his global PCB production and emissions model to the local scale of the City of Spokane. To do this, Mr. Coghlan simply scaled his inaccurate global emissions estimates down to the population of the State of Washington, then further scaled this value down to the population of the City of Spokane. Mr. Coghlan cites to Breivik *et al*. (2007) for support for his methodology, but Mr. Coghlan's methodology does not follow the recommendation of the Breivik *et al*. quote that Mr. Coghlan cites: "According to Breivik, 'population density is considered a suitable surrogate parameter' for estimating PCB consumption, given that PCBs are generally linked with use of electrical equipment" (Coghlan, 2019b, p. 42). Population density is not the same as total population, as a large rural area could have the same total population as a small urban area, and PCB consumption is not the same as PCB emissions. Therefore, the support Mr. Coghlan cites to for his methodology in fact does not support his methodology.

Using his flawed methodology, which lacks peer-reviewed support, Mr. Coghlan ultimately estimates that there are 100,000 lbs of PCBs in the environment in Spokane. A significant flaw in Mr. Coghlan's analysis is that his population-based scaling methodology does not account for the types of industries that are actually present in the City of Spokane. A global mass balance model such as Breivik *et al*.'s does not need to account for which industries are located where, because they are all included within the global estimate. Extrapolating Breivik *et al*.'s methodology to a small City based solely on population completely ignores the actual companies, facilities, and practices that are in place locally.

Furthermore, Mr. Coghlan did not validate his estimate of 100,000 lbs of PCBs in the Spokane environment in any way. If there are 100,000 lbs of PCBs in the environment, where does Mr. Coghlan think they are? No study has provided support for this amount of PCBs released to the environment in Spokane, and the City's own expert, Mr. Dilks, has asserted that the amount of PCBs in the Spokane River is 1,475 mg/day, equal to 1.18 lbs/year (Dilks, 2019). If there were 100,000 lbs of PCBs somewhere in the environment in Spokane, why is the PCB loading in the Spokane River less than 0.001% of that value? The fact that Mr. Coghlan did not attempt to reconcile these large differences between his estimate and the actual known PCB loading in the Spokane River shows that his methodology lacks support and validation.

Finally, Mr. Coghlan inappropriately relied on Table 4 from LimnoTech (2016a), which estimated the mass of PCBs in fixed sources such as buildings within the Spokane River watershed. This estimate from LimnoTech is baseless, and Mr. Coghlan's reliance on this value and reproduction of it in his report is inappropriate. To arrive at this estimate, LimnoTech (2016a) cites two studies that estimated the mass of PCBs present in buildings in Toronto (Diamond *et al*., 2010) and Chicago (Shanahan *et al*., 2015). To estimate PCBs present in buildings in Toronto, Diamond *et al*. (2010) sampled sealants in 80 buildings and used these measurements to scale up their estimate to the entire city, using the following information on the city's buildings: the year the building was built, the building volume, the building type, *etc*. Similarly, Shanahan *et al*. (2015) tabulated building footprints, ages, numbers of stories, *etc*., for every single parcel in the City of Chicago.

LimnoTech (2016a) did not perform any of these steps in its estimate of the amount of PCBs in buildings in Spokane, and Mr. Coghlan did not do any further estimates beyond what LimnoTech estimated. In fact, neither LimnoTech nor Mr. Coghlan have any data on PCBs in building sealants in Spokane, nor did they do a comprehensive inventory of the types of buildings in Spokane, the years they were built, whether PCB-containing sealants were used, or if any such sealants were removed. In addition, neither Mr. Coghlan nor LimnoTech compared the types of buildings and industries present in Spokane with those in either Chicago or Toronto. In summary, Mr. Coghlan's use of the values in Table 4 from LimnoTech (2016a) is baseless.

7.5 Rebuttal to Dr. Carpenter

Several of the statements made by the City's expert David Carpenter in his report (Carpenter, 2019), which I detail below, are misleading or inaccurate.

Statement 1: *"...PCBs can exist in environmental media for many years. For example, Lake et al. (1992) estimated the half-life of PCB 153 to be 18.8 years" (Carpenter, 2019, p. 10).*

Although it is true that PCBs can persist for years in the environment, they can also degrade within only weeks or months. Table 4.3 of my report lists estimated PCB degradation half-lives in air and soil/sediment (Mackay *et al*., 1992, Table 4.5; Paasivirta and Sinkkonen, 2009, Table 1). In air, PCBs with five or fewer chlorine atoms have an estimated degradation half-life of at most 130 days. A major reason for the rapid degradation of atmospheric PCBs is photodegradation, which Dr. Carpenter does not discuss (addressed further below).

The single half-life that Dr. Carpenter provides (for PCB 153, a hexachlorobiphenyl) is not representative of PCB degradation rates more broadly. PCB 153 is heavily chlorinated and has a half-life that is many factors larger than that of lighter congeners (see Table 4.3). In fact, Dr. Carpenter's source for this value (Lake *et al*., 1992, as cited in Carpenter, 2019) reports shorter half-lives for two pentachlorobiphenyls, PCB 105 (4.4-7.5 years) and PCB 118 (6.8 years). Moreover, the reported half-life for PCB 153 applies only to estuarine sediments (Lake *et al*., 1992, Table 3, as cited in Carpenter, 2019). As shown in Lake *et al*.'s Table 1, degradation is an order of magnitude slower for hexachlorobiphenyls in soil/sediment (where biodegradation predominates) than in air (where photodegradation predominates).

Statement 2: *"While this process [aerobic biodegradation] can result [in] ...degradation of PCBs, it is limited because most sediments are not aerobic..." (Carpenter, 2019, p. 10).*

It is true that most sediments are anaerobic at depth and are only aerobic near the water-sediment interface. However, once released to the environment, PCBs accumulate at the aerobic water-sediment interface and mix only slowly (on the order of years) into deeper, anaerobic sediments (WA Ecology, 2001). In the years immediately following a PCB release, more PCBs will be subject to aerobic degradation than anaerobic degradation.

Statement 3: *"…[A]erobic bacterial degradation occur[s] only in those congeners with a 2,3 (ortho-meta) position of the chlorines…" (Carpenter, 2019, p. 10).*

This is entirely incorrect. The 2,3-dioxygenase pathway by which aerobic degradation occurs targets the *ring* between its *ortho* and *meta* positions. The "2,3" designation has nothing whatsoever to do with the arrangement of chlorine atoms around the ring. Contrary to Dr. Carpenter's statement, all light PCB congeners are degraded by aerobic bacteria (Abramowicz, 1990, Section II.B; NRC, 2001, Appendix E).

Statement 4: *"Anaerobic bacteria… act to partially dechlorinate PCBs, rather than breaking the molecule… removing chlorines from the* meta *and* para *positions… Anerobic bacteria cannot… [attack]… chlorines at the* ortho *positions" (Carpenter, 2019, p. 10).*

This statement is false and misleading for three reasons. Firstly, contrary to Dr. Carpenter's statement, anaerobic bacteria can fully (not just partially) dechlorinate PCBs to biphenyl when chlorines are in the *meta* or *para* positions (NRC, 2001, Appendix E). Secondly, although *meta* and *para* anaerobic dechlorination is more widely observed than *ortho* dechlorination, *ortho* dechlorination is possible (NRC, 2001, Appendix E). Thirdly, this statement is misleading because it places undue focus on the inability of anaerobic bacteria to "break" the biphenyl ring. As stated by Abramowicz (1990, p. 246), "[t]he end result of [anaerobic degradation]… is the conversion of the more highly chlorinated PCBs into congeners of low toxicity that are degraded by a large number of aerobic bacteria." All that is required for complete degradation of an anaerobically degraded PCB is environmental migration into an aerobic setting. Migration is likely because light (*i.e.*, dechlorinated) congeners are far more mobile in the environment than their heavy precursors (NRC, 2001, Appendix E).

Beyond these misleading and inaccurate statements, Dr. Carpenter does not mention photodegradation, which is not only a major PCB degradation pathway but also occurs at a faster rate than biodegradation in the atmosphere and pristine surface waters (Paasivirta and Sinkkonen, 2009, pp. 1192-1193). Also, interestingly, although it is true (as indicated by Dr. Carpenter) that anaerobic degradation of *ortho* chlorines is rarely observed, photodegradation occurs more quickly for *ortho* chlorines than for *meta* or *para* chlorines (Paasivirta and Sinkkonen, 2009, pp. 1193).

References

Abramowicz, DA. 1990. "Aerobic and anaerobic biodegradation of PCBs: A review." *Crit. Rev. Biotechnol.* 10(3):241-251.

Agency for Toxic Substances and Disease Registry (ATSDR). 1990. "Preliminary Health Assessment for General Electric (Spokane Shop), Spokane, Washington (CERCLIS No. WAD001865450)." 15p., June 1.

Alta Geosciences, Inc. 1997. "Draft Completion Report, Removal Action Construction, Spokane Junkyard and Associated Properties Superfund Site, Spokane, Washington." Report to Spokane Junkyard Cleanup Committee. 126p., January.

Anderson, WC. 2002. "A history of environmental engineering in the United States." In *Proceedings of the Environmental and Water Resources History Sessions at ASCE Civil Engineering Conference and Exposition 2002, Washington, DC, November 3-7*. (Eds.: Rogers, JR; Fredrich, AJ), American Society of Civil Engineers. p1-12. doi: 10.1061/40650(2003)1.

Anezaki, K; Kannan, N; Nakano, T. 2014. "Polychlorinated biphenyl contamination of paints containing polycyclic- and Naphthol AS-type pigments." *Environ. Sci. Pollut. Res. Int.* doi: 10.1007/s11356-014-2985-6.

Anezaki, K; Nakano, T. 2013. "Polychlorinated biphenyl contamination in polycyclic-type pigments and silicone-based glues." *Organohalogen Compounds* 75:517-520.

Anezaki, K; Nakano, T. 2014. "Concentration levels and congener profiles of polychlorinated biphenyls, pentachlorobenzene, and hexachlorobenzene in commercial pigments." *Environ. Sci. Pollut. Res. Int.* 21(2):998-1009. doi: 10.1007/s11356-013-1977-2.

Anezaki, K; Nakano, T. 2015. "Unintentional PCB in chlorophenylsilanes as a source of contamination in environmental samples." *J. Hazard. Mater.* 287:111-117. doi: 10.1016/j.jhazmat.2015.01.026.

Armour, JA; Burke, JA. 1970. "Method for separating polychlorinated biphenyls from DDT and its analogs." *J. Assoc. Off. Anal. Chem.* 53(4):761-768.

Arnold, T. [Spokane, Washington, Wastewater Management]. 2000. Email to L. Hendron, *et al*. (Spokane, Washington) [re: Wastewater Facility Plan (WWFP) approval status]. 1p., January 11.

Bagley, GE; Reichel, WL; Cromartie, E. 1970. "Identification of polychlorinated biphenyls in two bald eagles by combined gas-liquid chromatography-mass spectrometry." *J. Assoc. Off. Anal. Chem.* 53(2):251-261.

Baker, RA; ed. 1980. *Contaminants and Sediments - Volume 1: Fate and Transport, Case Studies, Modeling, Toxicity*. Ann Arbor Science Publishers, Ann Arbor, MI. 558p.

Balistrieri, LS. 1998. "Preliminary estimates of benthic fluxes of dissolved metals in Coeur d'Alene Lake, Idaho." US Geological Survey (USGS). USGS Open-File Report 98-793. 40p.

Bevenue, A; Ogata, JN. 1970. "A note on the use of Florisil adsorbent for the separation of polychlorobiphenyls from chlorinated pesticides." *J. Chromatogr.* 50:142-144.

Borgias, A; Krapas, D. 2014. Emails between A. Borgias (WADOE) and D. Krapas (Inland Empire Paper Co.), *et al*. re: PCB TSCA Reform Coalition Agenda_102814. October 28, November 4.

Bovay Northwest, Inc. 1994. "Combined Sewer Overflow Reduction Plan." Report to Spokane, Washington, Dept. of Public Works, Engineering Division. 455p., January.

Breivik, K; Sweetman, A; Pacyna, JM; Jones, KC. 2002. "Towards a global historical emission inventory for selected PCB congeners - A mass balance approach. 2. Emissions." *Sci. Total Environ*. 290(1-3):199-224. doi: 10.1016/S0048-9697(01)01076-2.

Breivik, K; Sweetman, A; Pacyna, JM; Jones, KC. 2007. "Towards a global historical emission inventory for selected PCB congeners - A mass balance approach. 3. An update." *Sci. Total Environ.* 377(2-3):296-307. doi: 10.1016/j.scitotenv.2007.02.026.

Broadhurst, MG. 1972. "Use and replaceability of polychlorinated biphenyls." *Environ. Health Perspect.* 2:81-102.

Brown, JF; Bedard, DL; Brennan. 1987. "Polychlorinated Biphenyl Dechlorination in Aquatic Sediments." *Science* 236:709(4).

Burger, EJ. 1976. "A case study: Polychlorinated biphenyls." *J. Int. Soc. Technol. Assess.* 2:29-36.

Cairns, T; Siegmund, EG. 1981. "PCBs: Regulatory history and analytical problems." *Anal. Chem.* 53(11):1183A-1191A.

Callahan, MAA; Hammerstrom, KA; Schweer, G. 1983. "Present PCB uses and their potential for release to the environment." In *Proceedings, PCB-Seminar held September 28-30, Scheveningen, The Hague, The Netherlands*. (Eds.: Barros, MC; Koeneman, H; Visser, R), Netherlands, Ministry of Housing, Physical Planning and Environment. p152-172.

Capozzi, SL; Jing, R; Rodenburg, LA; Kjellerup, BV. 2019. "Positive Matrix Factorization analysis shows dechlorination of polychlorinated biphenyls during domestic wastewater collection and treatment." *Chemosphere* 216:289-296. doi: 10.1016/j.chemosphere.2018.10.151.

Cargill, D. [WA Ecology]. 2014. "PCBs from Building Materials and Other Sources in the Urban Environment." Presented at the 2014 Salish Sea Ecosystem Conference, Seattle, WA. 20p., April 30.

Carpenter, DO. 2019. "Expert Report of David O. Carpenter, M.D., City of Spokane *v*. Monsanto Company, *et al*." 25p., August 12.

CH2M HILL. 2014. "Integrated Clean Water Plan (Final)." Report to Spokane, Washington. 282p., December 31.

Christie, R. 2016. "Inadvertent PCB formation from a pigment chemistry perspective (GCE307)." Presented at the 20th Annual ACS Green Chemistry & Engineering Conference. 22p., June 16

Christie, RM. [Heriot-Watt University]. 2013. "Alternatives for Elimination of Polychlorinated Biphenyls (PCBs) in Pigments Used for Printing Inks and Architectural Paints." Presented at the National Pollution Prevention Roundtable "Advancing Green Chemistry: PCBs in Pigments" Webinar. 21p., June 27.

Clark, FM. [General Electric Co.]. 1933. "Diesel Materials for Electrical Devices." US Patent 1,931,455. 9p., October 17.

Clark, GM; Mebane, CA. 2014. "Sources, Transport, and Trends for Selected Trace Metals and Nutrients in the Coeur d'Alene and Spokane River Basins, Northern Idaho, 1990-2013." US Geological Survey (USGS). USGS Scientific Investigations Report 2014-5204. 74p.

Coghlan, KM. 2019a. "Videotaped deposition of Kevin M. Coghlan [re: City of Spokane *vs*. Monsanto Co., *et al*.]." Submitted to US District Court, Eastern District of Washington. 108p., October 30.

Coghlan, KM. [Environmental Health & Engineering, Inc.] 2019b. "Assessment of Sources of Polychlorinated Biphenyls in the Environment in and Around the City of Spokane, Washington." Report to Baron & Budd. 96p., October 11.

Commission for Environmental Cooperation (CEC). 1996. "Status of PCB Management in North America." 158p.

Condon, D. [Spokane, Washington]. 2019. "Written Testimony of Mayor David Condon 'The Clean Water State Revolving Fund: How Federal Infrastructure Investment Can Help Communities Modernize Water Infrastructure and Address Affordability Challenges.'" Submitted to US House of Representatives, Transportation and Infrastructure Committee, Subcommittee on Water Resources & Environment. 8p., March 7.

Cristol, SJ. [University of Colorado]. 1983. "Organic Chemical Processes Leading to Generation of Incidental Polychlorinated Biphenyls." Report to US EPA, Office of Toxic Substances. 6p., February 10.

Cui, S; Qi, H; Liu, LY; Song, WW; Ma, WL; Jia, HL; Ding, YS; Li, YF. 2013. "Emission of unintentionally produced polychlorinated biphenyls (UP-PCBs) in China: Has this become the major source of PCBs in Chinese air?" *Atmos. Environ.* 67:73-79. doi: 10.1016/j.atmosenv.2012.10.028.

Davies, H; Delistraty, D. 2016. "Evaluation of PCB sources and releases for identifying priorities to reduce PCBs in Washington State (USA)." *Environ. Sci. Pollut. Res. Int.* 23(3):2033-2041. doi: 10.1007/s11356-015-4828-5.

Davis, M. [Spokane, Washington]. 2019. "30 (B) (6) videotaped deposition of Marcia Davis [re: City of Spokane *vs*. Monsanto Co., *et al*.]. Volumes I-II." Submitted to US District Court, Eastern District of Washington. No.: 2:15-cv-00201-0. 371p., September 10, 11.

De Voogt, P; Wells, DE; Reutergardh, L; Brinkman, UAT. 1990. "Biological activity, determination and occurrence of planar, mono- and di-ortho PCBs." *Int. J. Environ. Anal. Chem*. 40(1-4):1-46. doi: 10.1080/03067319008030516.

Diamond, ML; Melymuk, L; Csiszar, SA; Robson, M. 2010. "Estimation of PCB stocks, emissions, and urban fate: Will our policies reduce concentrations and exposure?" *Environ. Sci. Technol.* 44(8):2777-2783. doi: 10.1021/es9012036.

Dilks, D. [LimnoTech]. 2019. "Expert Report of David Dilks, Ph.D. in the Matter of City of Spokane *v.* Monsanto Co., *et al*." 55p., October 10.

Donovan, J. [Spokane, Washington, RPWRF Laboratory]. 2012. "2011 Annual Summary of RPWRF Toxics Monitoring." 114p., March 9.

Donovan, J. [Spokane, Washington, RPWRF Laboratory]. 2013. "2012 Annual Summary of RPWRF Toxics Monitoring." 80p., August 20.

Donovan, J. [Spokane, Washington, RPWRF Laboratory]. 2014. "2013 Annual Summary of RPWRF Toxics Monitoring." 89p., April 9.

Donovan, J. [Spokane, Washington, RPWRF Laboratory]. 2015. "2014 Annual Summary of RPWRF Toxics Monitoring." 71p., September 9.

Dvorak, P; Gunther, M; Zorn, U; Catsch, A. 1971. "Metabolisches verhalten von kolloidalem ferrihexacyanoferrat(II) = Metabolic behaviour of colloidal ferrihexacyanoferrate(II)." *Naunyn Schmiedebergs Arch. Pharmakol.* 269:48-56.

Ecology and Environment, Inc. (E&E). 1988. "Site Inspection Report for Spokane Junkyard and Associated Sites, Spokane, Washington." Submitted to US EPA Region X. 64p.

Ecology and Environment, Inc. (E&E). 1991. "Final On-Scene Coordinator Report for Spokane Junkyard Removal, Spokane, Washington." Submitted to US EPA Region X. 64p., September.

Ecology and Environment, Inc. (E&E). 1998. "Potentially Responsible Party Search for the Spokane Junkyard and Associated Sites, Spokane, Washington." Report to Jacobs Engineering Group Inc. 160p.

Electric Power Research Institute (EPRI). 1999. "The PCB Information Manual, Volume I: Production, Uses, Characteristics, and Toxicity of PCBs (Final)." EPRI TR-114091-V1. 124p., December.

Environmental Defense Fund; Natural Resources Defense Council (NRDC); Chemical Manufacturers Association. 1983. "Recommendation of the Parties for a Final EPA Rule on Inadvertent Generation of PCBs." 61p., April 13.

Environmental Systems Research Institute (ESRI). 2019a. "World Imagery: Aerial imagery web mapping service." April 24. Accessed at https://www.arcgis.com/home/item.html?id=10df2279f9684e4a9f6a7f08febac2a9.

Environmental Systems Research Institute (ESRI). 2019b. "World Topographic Map." August 8. Accessed at https://www.arcgis.com/home/item.html?id=30e5fe3149c34df1ba922e6f5bbf808f.

Erickson, MD. 1997. *Analytical chemistry of PCBs (Second Edition)*. CRC Lewis Publishers, Boca Raton, FL. 667p.

Erickson, MD; Kaley, RG II. 2011. "Applications of polychlorinated biphenyls." *Environ. Sci. Pollut. Res. Int.* 18(2):135-151.

Esvelt & Saxton; Bovay Engineers, Inc. 1972. "Spokane Wastewater Study." 96p., July.

Esvelt Environmental Engineering. 2016. "Engineering Report: NPDES Permit (WA-0000825) Item S5, Treatment Technology Selection and Implementation to Meet Water Quality Based Effluent Limits." Report to Inland Empire Paper Co. 66p., October.

Feist, M. [Spokane, Washington]. 2019. "30 (B) (6) videotaped deposition of Marlene Feist [re: City of Spokane *vs*. Monsanto Co., *et al*.]. Volumes I-IV." Submitted to US District Court, Eastern District of Washington. Case No. 15-cv-00201-SMJ. 944p., July 16, 17, September 16, 17.

Fishmeal Information Network (FIN). 2008. "FIN Dossier 2008: Annual Review of the feed grade fish stocks used to produce fishmeal and fish oil for the UK market." 77p., May.

Frame, GM; Cochran, JW; Bowadt, SS. 1996. "Complete PCB congener distributions for 17 Aroclor mixtures determined by 3 HRGC systems optimized for comprehensive, quantitative, congener-specific analysis." *J. High Resolut. Chromatogr.* 19(12):657-668.

GeoEngineers, Inc. 2009. "Final Cleanup Action Report, City Parcel Site, Spokane, Washington." Report to Washington State Dept. of Ecology (WA Ecology), Eastern Regional Office. 24p., October 5.

GeoEngineers, Inc.; Hubbard Gray Consulting, Inc.; HDR Engineering, Inc. 2011. "Spokane River Watershed Nonpoint Source Phosphorus Reduction Plan (Final)." 451p., December.

Golder Associates Inc. 1990. "Phase 5 Remedial Action Work Plan, East 4323 Mission Avenue, Spokane, Washington." Report to General Electric Co. 62p., May 16.

Gravity Consulting, LLC. 2015. "2014 Spokane River Field Sampling Report, Spokane River Regional Toxics Task Force, Washington and Idaho." Report to Spokane River Regional Toxics Task Force (SRRTTF). 236p., January.

Gravity Consulting, LLC. 2016. "Draft Final - 2015 Spokane River Field Sampling Report, Spokane River Regional Toxics Task Force, Washington and Idaho." Report to Spokane River Regional Toxics Task Force (SRRTTF). 73p., July.

Guo, J; Capozzi, SL; Kraeutler, TM; Rodenburg, LA. 2014. "Global distribution and local impacts of inadvertently generated polychlorinated biphenyls in pigments." *Environ. Sci. Technol.* 48:8573-8580. doi: 10.1021/es502291b.

Gustafson, CG. 1970. "PCB's - prevalent and persistent." *Environ. Sci. Technol.* 4(10):814-819. doi: 10.1021/es60045a008.

Hammond, PB; Nisbet, ICT; Sarofim, AF. 1972. "Polychlorinated biphenyls - environmental impact. A review by the Panel on Hazardous Trace Substances, March 1972." *Environ. Res.* 5(3):249-362.

Hart Crowser, Inc. 1991. "Letter Report to P. Blau (Kaiser Aluminum & Chemical Corp.) re: Interim PCB Cleanup Report, Kaiser Trentwood Works, Spokane, Washington." Submitted to Washington State Dept. of Ecology (WA Ecology) 25p., June 26.

Hart Crowser, Inc. 2012a. "Final Site-Wide Groundwater Remedial Investigation, Kaiser Trentwood Facility, Spokane Valley, Washington [Volumes I-II, Plates, and Appendices A-F]." Report to Kaiser Aluminum Washington, LLC. May.

Hart Crowser, Inc. 2012b. "Final Feasibility Technical Memorandum, Kaiser Trentwood Facility, Spokane Valley, Washington." Report to Kaiser Aluminum Washington, LLC. 641p., May.

Hart Crowser, Inc. 2012c. "Final Site-Wide Soil Remedial Investigation, Kaiser Trentwood Facility, Spokane Valley, Washington [Volumes I-II and Appendices A-C]." Report to Kaiser Aluminum Washington, LLC. May.

HDR Engineering, Inc. 2009. "Biosolids Management Plan (Final)." Report to Spokane County, Washington, Division of Utilities. 117p., September.

HDR, Inc. 2010. "2010 Wastewater Facilities Plan Amendment (Final)." Report to Spokane County, Washington, Division of Utilities. 103p., June 16.

Hendron, L. [Spokane, Washington]. 2019. "30 (B) (6) videotaped deposition of Lars Hendron [re: City of Spokane *vs*. Monsanto Co., *et al*.]." Submitted to US District Court, Eastern District of Washington. Case No. 15-cv-00201-SMJ. 378p., June 7.

Hess, AD; Keener, GG Jr. 1947. "The effectiveness of DDT residual house sprays in controlling Anopheles quadrimaculatus." *Am. J. Hyg.* 45(2):133-143.

Hill, K. 2019. "Millions of gallons of untreated runoff entered the Spokane River after major May rainstorm, report says." *Spokesman-Review* July 13. Accessed at https://www.spokesman.com/stories/2019/jul/13/millions-of-gallons-of-untreated-runoff-entered-th.

Hu, D; Hornbuckle, KC. 2010. "Inadvertent polychlorinated biphenyls in commercial paint pigments." *Environ. Sci. Technol.* 44(8):2822-2827. doi: 10.1021/es902413k.

Huang, J; Gao, J; Yu, G; Yamazaki, N; Deng, S; Wang, B; Weber, R. 2015. "Unintentional formed PCDDs, PCDFs, and DL-PCBs as impurities in Chinese pentachloronitrobenzene products." *Environ. Sci. Pollut. Res.* 22(19):14462-14470. doi: 10.1007/s11356-014-3507-2.

Hubbard, HL. [Monsanto Co.; Industry]. 1964. "Chlorinated biphenyl and related compounds." In *Kirk-Othmer Encyclopedia of Chemical Technology (Second Edition). Volume 5*. Wiley & Sons, New York. p289-297.

Humphrey, J. 2014. "Snowmelt causes sewage to seep into Spokane River." *KXLY.com* February 12. Accessed at https://www.kxly.com/news/local-news/spokane/snowmelt-causes-sewage-to-seep-into-spokane-river_20161121082903958/177623170.

Idaho Dept. of Fish and Game (IDFG). 2013. "Fisheries Management Plan, 2013-2018: A Comprehensive Guide to Managing Idaho's Fisheries Resources." 367p.

Idaho Fish and Game. 2017. "Historical Stocking Records." Accessed at https://idfg.idaho.gov/ifwis/fishingPlanner/stocking/?region=1.

Inland Empire Paper Co. (IEP). 2013. "Inland Empire effluent, process water, and product sample results (2002-2013)." 2235p.

Inland Empire Paper Co. (IEP). 2015a. "Inland Empire Paper Company NPDES Permit No. WA-000082-5 Permit Condition S6.A: Polychlorinated Biphenyl Source Identification Study." 60p., October 30.

Inland Empire Paper Co. (IEP). 2015b. "Inland Empire effluent sample results (August 2015)." 8p.

Inland Empire Paper Co. (IEP). 2016a. "Inland Empire Paper Company NPDES Permit No. WA-000082-5 Permit Condition S6.B: Polychlorinated Biphenyls Best Management Practices Plan Update, 2016 Report." 24p., November 1.

Inland Empire Paper Co. (IEP). 2016b. "Inland Empire effluent sample results (2014-2016)." 776p.

Inland Empire Paper Co. (IEP). 2016c. "Inland Empire effluent sample results (December 2015 and January 2016)." 14p.

Inland Empire Paper Co. (IEP). 2016d. "Inland Empire effluent sample results (August 2016)." 14p.

Inland Empire Paper Co. (IEP). 2017a. "Inland Empire effluent sample results (July 2017)." 10p.

Inland Empire Paper Co. (IEP). 2017b. "Inland Empire Paper Company (IEP) 2017 Q1 PCB results." March 14.

Interdepartmental Task Force on PCBs (ITF). 1972a. "Polychlorinated Biphenyls and the Environment." National Technical Information Service (NTIS). NTIS COM-72-10419. 192p., March.

Interdepartmental Task Force on PCBs (ITF). 1972b. "Polychlorinated biphenyls and the environment (Excerpts)." Report to US Dept. of Agriculture; US EPA. National Technical Information Service (NTIS). NTIS COM-72-10419, p1-5, 44-45, 51-53, 75-81, May.

International Agency for Research on Cancer (IARC). 2015. "IARC Monographs on the Evaluation of Carcinogenic Risks to Humans: Volume 107: Polychlorinated and Polybrominated Biphenyls." International Agency for Research on Cancer, Lyon, France; World Health Organization (WHO), Geneva, Switzerland. IARC Monograph No. 107, 513p.

International Programme on Chemical Safety (IPCS). 1976. "Environmental Health Criteria 2: Polychlorinated biphenyls and terphenyls [First edition]." Report to World Health Organization (WHO); United Nations Environment Programme; International Labour Organisation. 67p.

Ishikawa, Y; Noma, Y; Yamamoto, T; Mori, Y; Sakai, SI. 2007. "PCB decomposition and formation in thermal treatment plant equipment." *Chemosphere* 67(7):1383-1393. doi: 10.1016/j.chemosphere.2006.10.022.

Jaward, FM; Farrar, NJ; Harner, T; Sweetman, AJ; Jones, KC. 2004. "Passive air sampling of PCBs, PBDEs, and organochlorine pesticides across Europe." *Environ. Sci. Technol.* 38(1):34-41.

Jiang, X; Liu, G; Wang, M; Zheng, M. 2015. "Formation of polychlorinated biphenyls on secondary copper production fly ash: Mechanistic aspects and correlation to other persistent organic pollutants." *Sci. Rep.* 5:13903. doi: 10.1038/srep13903.

Kahle, SC; Bartilino, JR. 2007. "Hydrogeologic Framework and Ground-Water Budget of the Spokane Valley-Rathdrum Prairie Aquifer, Spokane County, Washington, and Bonner and Kootenai Counties, Idaho." US Geological Survey (USGS). USGS Scientific Investigations Report 2014-5041. 60p.

Kalmaz, EV; Kalmaz, GD. 1979. "Transport, Distribution, and Toxic Effects of Polychlorinated Biphenyls in Ecosystems: Review." *Ecol. Modeling.* 6:223(29).

Kannan, N; Schulz-Bull, DE; Petrick, G; Duinker, JC. 1992. "High resolution PCB analysis of kanechlor, phenoclor and sovol mixtures using multidimensional gas chromatography." *Int. J. Environ. Anal. Chem*. 47(3):201-215. doi: 10.1080/03067319208027029.

Kim, KS; Hirai, Y; Kato, M; Urano, K; Masunaga, S. 2004. "Detailed PCB congener patterns in incinerator flue gas and commercial PCB formulations (Kanechlor)." *Chemosphere* 55(4):539-553. doi: 10.1016/j.chemosphere.2003.11.056.

Krapas, DP. [Inland Empire Paper Co.]. 2016. Letter to P. Hallinan (Washington State Dept. of Ecology) re: Inland Empire Paper Company NPDES Permit No. WA 000082-5 renewal. 46p., April 29.

Law, RJ. 1995. "3,3'-dichlorobenzidine: A candidate for inclusion in marine monitoring programmes?" *Chemosphere* 30(9):1791-1797. doi: 10.1016/0045-6535(95)00063-E.

Leoni, V. 1971. "The separation of fifty pesticides and related compounds and polychlorobiphenyls into four groups by silica gel microcolumn chromatography." *J. Chromatogr*. 62:63-71.

Li, Y; Harner, T; Liu, L; Zhang, Z; Ren, N; Jia, H; Ma, J; Sverko, E. 2010. "Polychlorinated biphenyls in global air and surface soil: Distributions, air-soil exchange, and fractionation effect." *Environ. Sci. Technol.* 44(8):2784-2790.

LimnoTech. 2015a. "Spokane River Regional Toxics Task Force Phase 2 Technical Activities Report (Draft)." Report to Spokane River Regional Toxics Task Force (SRRTTF). 36p., May 20.

LimnoTech. 2015b. "Spokane River Regional Toxics Task Force Phase 2 Technical Activities Report: Identification of Potential Unmonitored Dry Weather Sources of PCBs to the Spokane River." Report to Spokane River Regional Toxics Task Force (SRRTTF). 62p., August 12.

LimnoTech. 2016a. "2016 Comprehensive Plan to Reduce Polychlorinated Biphenyls (PCBs) in the Spokane River." Report to Spokane River Regional Toxics Task Force. 125p., November 29.

LimnoTech. 2016b. "Draft: Spokane River Regional Toxics Task Force 2015 Technical Activities Report: Continued Identification of Potential Unmonitored Dry Weather Sources of PCBs to the Spokane River." Report to Spokane River Regional Toxics Task Force (SRRTTF). 68p., June 30.

LimnoTech. 2017. "Spokane River Regional Toxics Task Force 2016 Monthly Monitoring Report (Draft)." Report to Spokane River Regional Toxics Task Force (SRRTTF). 42p., May 4.

LimnoTech. 2018. Memorandum to Spokane River Regional Toxics Task Force re: Comparison of Homolog-Patterns for Groundwater Well Data and Suspected Loads. 27p., January 22.

LimnoTech. 2019a. "Spokane River Regional Toxics Task Force 2018 Technical Activities Report: Continued Identification of Potential Unmonitored Dry Weather Sources of PCBs to the Spokane River (Draft)." Report to Spokane River Regional Toxics Task Force (SRRTTF). 46p., February 20.

LimnoTech. 2019b. "Spokane River Regional Toxics Task Force, 2018 Technical Activities Report: Continued Identification of Potential Unmonitored Dry Weather Sources of PCBs to the Spokane River." Report to Spokane River Regional Toxics Task Force. No: 124. 46p., March 27.

Lippmann, M; Schlesinger, RB. 1979. *Chemical Contamination in the Human Environment*. Oxford University Press, New York, NY. 456p.

Little, JC; Hodgson, AT; Gadgil, AJ. 1994. "Modeling emissions of volatile organic compounds from new carpets." *Atmos. Environ*. 28(2):227-234. doi: 10.1016/1352-2310(94)90097-3.

Liu, W; Li, H; Tao, F; Li, S; Tian, Z; Xie, H. 2013a. "Formation and contamination of PCDD/Fs, PCBs, PeCBz, HxCBz and polychlorophenols in the production of 2,4-D products." *Chemosphere* 92(3):304-308. doi: 10.1016/j.chemosphere.2013.03.031.

Liu, G; Zheng, M; Cai, M; Nie, Z; Zhang, B; Liu, W; Du, B; Dong, S; Hu, J; Xiao, K. 2013b. "Atmospheric emission of polychlorinated biphenyls from multiple industrial thermal processes." *Chemosphere* 90(9):2453-2460. doi: 10.1016/j.chemosphere.2012.11.008.

Mackay, D; Shiu, WY; Ma, KC. 1992. *Illustrated Handbook of Physical-Chemical Properties and Environmental Fate for Organic Chemicals, Volume I: Monoaromatic Hydrocarbons, Chlorobenzenes, and PCBs*. Lewis Publishers, Inc., Chelsea, MI. 697p.

McLerran, DJ. [US EPA Region X]. 2015. Letter to A. Borgias (WA Ecology) [re: Water quality challenges presented by polychlorinated biphenyls]. 3p., February 24.

Middleton, FM; Rosen, AA. 1956. "Organic contaminants affecting the quality of water." Public Health Rep. 71(11):1125-1133.

Monsanto Co. (Monsanto). 1970. "Call Report [re: PRC Japanese Kanechlors]." Organic Division. 1p., December 7.

Monsanto Co. (Monsanto). 1971a. "Call Report [re: Sonneborn Building Products Aroclor inventory and purchase of Japanese 'Aroclor']." Organic Division. 1p., July 27.

Monsanto Co. (Monsanto). 1971b. "Call Report [re: Polymeric Systems - Sonneborn purchases of Kanechlor]." Organic Division. 1p., November 17.

Monsanto Co. (Monsanto). c. 1980. "Polychlorinated Biphenyls (PCB's): A Report on Uses, Environmental and Health Effects and Disposal." 28p.

Monsanto. 1975. "Environmental Presence Polychlorinated Biphenyls (Draft)." 3p., July 29.

Morrison, RD; Murphy, BL; eds. 2006. *Environmental Forensics: Contaminant Specific Guide*. Academic Press, Burlington, MA. 541p.

Myriad Systems & Services, Inc. 1990. "Final Baseline Report, Spokane Transformer Site, Spokane, Washington." Report to US EPA. 61p., March 21.

National Research Council (NRC). 2001. "A Risk Management Strategy for PCB-Contaminated Sediments." Commission on Life Sciences, Board on Environmental Studies and Toxicology, Committee on Remediation of PCB-Contaminated Sediments. National Academy Press, Washington, DC. 432p.

Neely, WB. 1980. *Chemicals in the Environment: Distribution, Transport, Fate, Analysis*. Marcel Dekker Inc., New York, NY. 245p.

New Scientist. 1966. "Report of a new chemical hazard [reporting on the work of Soren Jensen]." *New Scientist* 612.

Nicholson, HP. 1959. "Insecticide pollution of water resources." *J. Am. Water Works Assoc.* 51(8):981-986.

Office of the City Attorney. 2019. "Plaintiff's third supplement to plaintiff's second amended objections and responses to Pharmacia LLC's first amended special interrogatories [re: City of Spokane *vs*. Monsanto Co., *et al*.]. Set One." Spokane, WA. Submitted to US District Court, Eastern District of Washington. Case No.: 2:15-cv-00201-SMJ. 160p., July 2.

Paasivirta, J; Sinkkonen, SI. 2009. "Environmentally relevant properties of all 209 polychlorinated biphenyl congeners for modeling their fate in different natural and climatic conditions." *J. Chem. Eng. Data* 54(4):1189-1213.

Paris, DF; Steen, WC; Baughman, GL. 1978. "Role of physico-chemical properties of Aroclors 1016 and 1242 in determining their fate and transport in aquatic environments." *Chemosphere* 7(4):319-325. doi: 10.1016/0045-6535(78)90130-3.

Parsons. 2007. "Spokane River PCB TMDL Stormwater Loading Analysis (Final Technical Report)." Report to US EPA Region X; Washington State Dept. of Ecology (WA Ecology). Publication No. 07-03-055. 52p., December.

Patmont, CR. [Harper-Owes]. 1987. "The Spokane River Basin: Allowable Phosphorus Loading (Final Report)." Report to Washington State Dept. of Ecology (WA Ecology). 186p., September.

Peakall, DB; Lincer, JL. 1970. "Polychlorinated biphenyls: Another long-life widespread chemical in the environment." *Bioscience* 20(17):958-964.

Pearce, Greeley & Hansen Hydraulic and Sanitary Engineers (Pearce, Greeley & Hansen). 1933. "Spokane, Washington, Report on Sewage Disposal." Report to Spokane, Washington. 119p., July.

Penning, CH. 1930. "Physical characteristics and commercial possibilities of chlorinated diphenyl." *Ind. Eng. Chem.* 22(11):1180-1182.

Perdih, A; Jan, J. 1994. "Formation of polychlorobiphenyls in silicone rubber." *Chemosphere* 28(12):2197-2202. doi: 10.1016/0045-6535(94)90187-2.

PTI Environmental Services. 1995. "Former Wastewater Treatment Plant Remedial Activities Report." Report to Pentzer Development Corp. 89p., September.

Reisdorph, AJ; Wilson, GM. 1963. "Welcome to the City of Spokane, Sewage Treatment Plant." 13p.

Robinson, JL. [Color Pigments Manufacturers Association, Inc. (CPMA)]. 2010. Letter to US EPA Docket re: Comments of the Color Pigments Manufacturers Association, Inc. on the Advanced Notice of Proposed Rulemaking Regarding Reassessment of Use Authorizations for Polychlorinated Biphenyls, 75 Fed. Reg. 17645, April 7, 2010, Docket Control No. EPA-HQ-OPPT-2009-0757. EPA-HQ-OPPT-2009-0757. 43p., August 18.

Rodenburg, L. 2016. "PCB contamination from silicone rubber." August 24. Accessed at http://supersewers.blogspot.com/2016/08/pcb-contamination-from-silicone-rubber.html.

Rodenburg, LA. [Rutgers University]. 2012. "Inadvertent PCB Production and Its Impact on Water Quality." Presented at the ECOS Annual Meeting, Colorado Springs, CO. 11p., August 28. Accessed at http://srrttf.org/wp-content/uploads/2012/08/Lisa-Rodenburg-Slideshow.pdf.

Rodenburg, LA. [Rutgers University]. 2017. "PCBs: An Update." 67p., September 25.

Rodenburg, LA. [Rutgers University]. 2018. "Videotape deposition of Lisa A. Rodenburg, Ph.D. [re: City of Hartford and Hartford Board of Education *vs*. Monsanto Co., *et al*.]." Submitted to US District Court, District of Connecticut. No. 3:15-CV-01544(RNC). 216p., February 7.

Rodenburg, LA; Guo, J; Du, S; Cavallo, GJ. 2010. "Evidence for unique and ubiquitous environmental sources of 3,3'-dichlorobiphenyl (PCB 11)." *Environ. Sci. Technol.* 44(8):2816-2821. doi: 10.1021/es901155h.

Rushneck, DR; Beliveau, A; Fowler, B; Hamilton, C; Hoover, D; Kaye, K; Berg, M; Smith, T; Telliard, WA; Roman, H; Ruder, E; Ryan, L. 2004. "Concentrations of dioxin-like PCB congeners in unweathered Aroclors by HRGC/HRMS using EPA Method 1668A [see notes field for correction notice]." *Chemosphere* 54(1):79-87. doi: 10.1016/S0045-6535(03)00664-7.

Sankarasubramanian, A; Vogel, RM. 2003. "Hydroclimatology of the continental United States." *Geophysical Res. Lett.* 30(7):1363.

Schipp, G. [Darwin Aquaculture Centre]. 2008. "Is the Use of Fishmeal and Fish Oil in Aquaculture Diets Sustainable?" Australia, Northern Territory Government, Dept. of Primary Industry and Resources. Technote No. 124. 15p., June.

Schmidt, H; Schultz, G. 1881. "Ueber benzidin (alpha-diamidodiphenyl)." *Justus Liebigs Ann. Chem*. 207(3):320-347. doi: 10.1002/jlac.18812070306.

Schmidt, L. [Spokane, Washington, Wastewater Management]. 2014. "The Search for Inadvertently Produced PCBs." Presented at the Spokane River Forum 2014, Coeur D'Alene, Idaho. 31p.

Schultz, G. 1881a. "Ueber diphenylbasen." *Justus Liebigs Ann. Chem*. 207(3):311-319. doi: 10.1002/jlac.18812070305.

Schultz, G. 1881b. "Ueber die constitution der diphenylderivate." *Justus Liebigs Ann. Chem*. 207(3):361-368. doi: 10.1002/jlac.18812070308.

Schultz, G; Schmidt, H; Strafser, H. 1881. "Ueber diphenylin (beta-diamidodiphenyl)." *Justus Liebigs Ann. Chem*. 207(3):348-360. doi: 10.1002/jlac.18812070307.

Science Applications International Corp. (SAIC). 2002. "Final Remedial Investigation Work Plan, City Parcel Site, Spokane, Washington." Report to Washington State Dept. of Ecology (WA Ecology), Eastern Regional Office. 63p., February 1.

Science Applications International Corp. (SAIC). 2003. "Final Report of Wastewater and Sludge Sampling at Inland Empire Paper Company, Spokane, Washington (Revision 1)." Report to Washington State Dept. of Ecology (WA Ecology). 74p., April 4.

Shanahan, CE; Spak, SN; Martinez, A; Hornbuckle, KC. 2015. "Inventory of PCBs in Chicago and opportunities for reduction in airborne emissions and human exposure." *Environ. Sci. Technol.* 49(23):13878-13888. doi: 10.1021/acs.est.5b00906.

Shang, H; Li, Y; Wang, T; Wang, P; Zhang, H; Zhang, Q; Jiang, G. 2014. "The presence of polychlorinated biphenyls in yellow pigment products in China with emphasis on 3,3'-dichlorobiphenyl (PCB 11)." *Chemosphere* 98:44-50. doi: 10.1016/j.chemosphere.2013.09.075.

Shifrin, NS; Toole, AP. 1998. "Historical perspective on PCBs." *Environ. Eng. Sci.* 15(3):247-257.

Simmons, S. [Spokane, Washington, Dept. of Public Works]. 2017. Letter to A. Borgias (Washington State Dept. of Ecology, Eastern Regional Office) re: Administrative Order 14235, City of Spokane NPDES Permit WA 0024473. 2p., December 26.

Sinkkonen, S; Paasivirta, J. 2000. "Degradation half-life times of PCDDs, PCDFs and PCBs for environmental fate modeling." *Chemosphere* 40(9-11):943-949. doi: 10.1016/S0045-6535(99)00337-9.

Smoke, JA. [Monsanto Co.]. 1971. "Internal memorandum to W. Clark [re: Sonneborn Building Products use of PCBs]." 1p., August 13.

Soltero, RA; Humphreys, LM; Sexton, LM. [Eastern Washington University]. 1990. "Impact of Combined Sewer/Storm-Water Overflows on the Spokane River, Washington." Report to Bovay Northwest Inc. 79p., October.

Song, S; Xue, J; Lu, Y; Zhang, H; Wang, C; Cao, X; Li, Q. 2018. "Are unintentionally produced polychlorinated biphenyls the main source of polychlorinated biphenyl occurrence in soils?" *Environ. Pollut.* 243(Pt. A):492-500. doi: 10.1016/j.envpol.2018.09.027.

Spokane County, Washington, Public Works Dept. (SCPWD). 2015. "NPDES Permit Renewal Application, Spokane County Regional Water Reclamation Facility (Permit No. WA-0093317)." Utilities Division. Submitted to Washington State Dept. of Ecology (WA Ecology). 81p., October 1.

Spokane County, Washington. 2017. "Parcel Boundary GIS File, Spokane County, WA."

Spokane Daily Chronicle. 1938. "Coeur d'Alene City authorizes election on sewage disposal system bonds." *Spokane Daily Chronicle* 1p., August 6.

Spokane River Regional Toxics Task Force (SRRTTF). 2015. "Hydroseed Pilot Project Summary Report." 54p., July 31.

Spokane, Washington, Wastewater Management Dept. (SWWM). 2013. "2013 Annual Report: Adaptive Management Plan for Reducing PCBs in Stormwater Discharges (Reporting Period: May, 2012 to May, 2013)." 52p., June.

Spokane, Washington, Wastewater Management Dept. (SWWM). 2014. "2014 Annual Report: Adaptive Management Plan for Reducing PCBs in Stormwater Discharges (Reporting Period: May, 2013 to May, 2014)." 53p., June.

Spokane, Washington, Wastewater Management Dept. (SWWM). 2015a. "City of Spokane Stormwater Management Program (SWMP) 2014." Permit No. WAR04-6505. 48p.

Spokane, Washington, Wastewater Management Dept. (SWWM). 2015b. "City of Spokane PCB Reduction Activities." 15p., June 8.

Spokane, Washington, Wastewater Management Dept. (SWWM). 2015c. "PCBs in Municipal Products (Revised)." 45p., July 21.

Spokane, Washington, Wastewater Management Dept. (SWWM). 2015d. "NPDES Permit Renewal Application, Riverside Park Water Reclamation Facility (Permit No. WA-002447-3)." Submitted to Washington State Dept. of Ecology (WA Ecology). 76p., December 21.

Spokane, Washington, Wastewater Management Dept. (SWWM). 2019. "Combined Sewer Overflow Annual Report - 2018." Submitted to Washington State Dept. of Ecology (WA Ecology). 45p., August 27.

Spokane, Washington. 1977. "Facilities Planning Report for Sewer Overflow Abatement." Public Works Dept.. 118p.

Spokane, Washington. 1999-2017. "Compilation of Combined Sewer Overflow (CSO) annual report data." 31p.

Spokane, Washington. 2011. "Six Year Comprehensive Wastewater Program, 2012-2017." Public Works Dept. 79p., September 13.

Spokane, Washington. 2013. "Council action memorandum re: Final Reading Ordinance C35021 regarding low impact development." ORD C35021. 25p., September 3.

Spokane, Washington. 2016. "Evaluation of Polychlorinated Biphenyls in Deicer (Draft)." Environmental Programs. 24p., May 11.

Spokane, Washington. 2017a. "City of Spokane, WA Stormwater Outfalls, CSO Outfalls, MS4 Basins, CSO Basins, and Special Drainage Districts."

Spokane, Washington. 2017b. "Riverside Park Water Reclamation Facility." Public Works and Utilities. Accessed at https://my.spokanecity.org/publicworks/wastewater/treatment-plant.

Spokane, Washington. 2018. "Signals and lighting." Accessed at https://my.spokanecity.org/streets/signs-and-lights.

Spokane, Washington. 2019. "Combined Sewer Overflow Annual Report - 2017." Riverside Park Water Reclamation Facility. Submitted to Washington State Dept. of Ecology (WA Ecology). 49p., September 28.

Stemmler, I; Lammel, G. 2012. "Long-term trends of continental-scale PCB patterns studied using a global atmosphere-ocean general circulation model." *Environ. Sci. Pollut. Res.* 19(6):1971-1980. doi: 10.1007/s11356-012-0943-8.

SURDEX Corp. 2007. "Aerial Image of the Spokane, WA area."

Swann, RL; Eschenroeder, A; eds. 1983. *Fate of Chemicals in the Environment: Compartmental and Multimedia Models for Predictions*. American Chemical Society, Washington, DC. ACS Symposium Series 225. 330p.

Takasuga, T; Nakano, T; Shibata, Y. 2014. "Identification of PCB congeners by unintentional formation." *Organohalogen Compounds* 76:1430-1433.

Thibodeaux, LJ. 1979. *Chemodynamics: Environmental Movement of Chemicals in Air, Water, and Soil*. John Wiley & Sons, New York, NY. 522p.

Thomson, CJ. 1990. "The market for fish meal and oil in the United States: 1960-1988 and future prospects." *CalCOFI Rep.* 31:124-131.

Trapp, M; Bowdan, JE III. [Michael Baker International]. 2019. "FExpert [*sic*] Opinion Report of J. Michael Trapp and Joel E. Bowdan III, City of Spokane *V*. Monsanto Company, *et al*." 103p., October 11.

US Census Bureau. 2015. "TIGER/Line® shapefiles and TIGER/Line® files."

US Census Bureau. 2016a. "US County Boundaries."

US Census Bureau. 2016b. "US State Boundaries."

US Dept. of Agriculture (USDA). 1947. "Science in farming (excerpts)." In *The Yearbook of Agriculture 1943-1947*. p616-669.

US Dept. of Health, Education, and Welfare. 1958. "Statistical Summary of Sewage Works in the United States." Public Health Service. Public Health Service Publication No. 609. 43p.

US Dept. of the Interior. 1942. "Recreational Development of Roosevelt Lake." Bureau of Reclamation. Columbia Basin Joint Investigations Problem 26. 113p.

US EPA Region X. 1979. "Final Environmental Impact Statement, City of Spokane, Washington Combined Sewer Overflow Abatement Project." EPA-10-Wa-City 8 Co Spokane-CSO-79. 158p., July.

US EPA Region X. 2011. "Five-Year Review, Spokane Junkyard and Associated Properties Superfund Site, Spokane, Washington." 16p., September 23.

US EPA Region X. 2014. "Authorization to Discharge Under the National Pollutant Discharge Elimination System: Hayden Area Regional Sewer Board, 10789 North Atlas Road, Hayden, ID (Final)." Permit No.: ID0026590. 42p., September 30.

US EPA. 1973. "Raw Sewage Bubbles Up Into the Spokane River from the Spokane City Treatment Plant About Five Miles West of the City." 548090; 412-DA-5603. 1p., May. Accessed at https://catalog.archives.gov/id/548090.

US EPA. 1979. "Polychlorinated biphenyls (PCBs); Manufacturing, processing, distribution in commerce, and use prohibitions (Final rule)." *Fed. Reg.* 44(106):31514-31558. 40 CFR 761. May 31.

US EPA. 1982a. "Polychlorinated biphenyls (PCBs); Manufacturing, processing, distribution and use in closed and controlled waste manufacturing processes (Proposed)." *Fed. Reg.* 47:24976-24989. June 8.

US EPA. 1982b. "Methods of Analysis for By-Product PCBs - Literature Review and Preliminary Recommendations." Office of Toxic Substances. EPA-560/5-82-005. 137p., October.

US EPA. 1983. "Polychlorinated biphenyls; Exclusions, exemptions and use authorizations (Proposed rule)." *Fed. Reg.* 48(237):55076-55098. 40 CFR 761. December 8.

US EPA. 1984. "Toxic Substances Control Act; Polychlorinated biphenyls (PCBs) manufacturing, processing, distribution in commerce, and use prohibitions; Exclusions, exemptions and use authorizations (Final rule)." *Fed. Reg.* 49(133):28172-29066. 40 CFR 761, July 10.

US EPA. 1985a. "Analytical Method: The Analysis of By-Product Chlorinated Biphenyls in Water, Revision 2." Office of Toxic Substances. EPA-560/5-85-012. 57p., April.

US EPA. 1985b. "Analytical Method: The Analysis of By-Product Chlorinated Biphenyls in Commercial Products and Product Wastes, Revision 2." Office of Toxic Substances. EPA-560/5-85-010. 60p., April.

US EPA. 1985c. "Analytical Method: The Analysis of By-Product Chlorinated Biphenyls in Air, Revision 2." Office of Toxic Substances. EPA-560/5-85-011. 65p., April.

US EPA. 1997a. "Management of Polychlorinated Biphenyls in the United States." Office of Pollution Prevention and Toxics. 56p., January 30.

US EPA. 1997b. "EPA Method 1668: Toxic polychlorinated biphenyls by isotope dilution high resolution gas chromatography/high resolution mass spectrometry (Draft)." Office of Water. EPA 821-R-97-001; NTIS PB99-149213. 67p., March.

US EPA. 1999. "EPA Method 1668, Revision A: Chlorinated Biphenyl Congeners in Water, Soil, Sediment, and Tissue by HRGC/HRMS." Office of Water. EPA 821-R-00-002. 133p., December.

US EPA. 2017a. "Discharge Monitoring Report (DMR) Pollutant Loading Tool."

US EPA. 2017b. "USGS Discharge Monitoring Report (DMR) Site Locations, Spokane and Upper Columbia River Watersheds (WA and ID)." In *Enforcement and Compliance History Online (ECHO) Water Pollutant Loading Tool: Water Pollution Search*. Office of Enforcement and Compliance Assurance. Accessed at https://echo.epa.gov/trends/loading-tool/water-pollution-search.

US EPA. 2017c. "Frequent Questions about the Polychlorinated Biphenyl (PCB) Guidance Reinterpretation." August 10. Accessed at https://www.epa.gov/pcbs/frequent-questions-about-polychlorinated-biphenyl-pcb-guidance-reinterpretation.

US EPA. 2018a. "Overview of identifying and restoring impaired waters under Section 303(d) of the CWA." September 13. Accessed at https://www.epa.gov/tmdl/overview-identifying-and-restoring-impaired-waters-under-section-303d-cwa.

US EPA. 2018b. "National Primary Drinking Water Regulations." March 22. Accessed at https://www.epa.gov/ground-water-and-drinking-water/national-primary-drinking-water-regulations.

US EPA. 2019. "List of Approved Polychlorinated Biphenyl (PCB) Commercial Storage and Disposal Facilities." June 10. Accessed at https://www.epa.gov/pcbs/list-approved-polychlorinated-biphenyl-pcb-commercial-storage-and-disposal-facilities.

US Geological Survey (USGS). 1980. "Aerial Image of the Spokane, WA area." July 21.

US Geological Survey (USGS). 2003. "Occurrence and Transport of Cadmium, Lead, and Zinc in the Spokane River Basin, Idaho and Washington, Water Years 1999-2001." Water-Resources Investigations Report 02-4183. 45p.

US Geological Survey (USGS). 2018. "USGS stream gauge locations for the Spokane River, Washington." In *National Water Information System Web Interface: USGS Water Data for the Nation*. Accessed at https://waterdata.usgs.gov/usa/nwis.

US Navy. 1944. "Manual on DDT Insecticide." Bureau of Medicine and Surgery. NAVMED 292. 19p.

US Tariff Commission. 1950. "Synthetic Organic Chemicals, United States Production and Sales, 1949 (Excerpts)." Report No. 169, Second Series. p1-7.

US Tariff Commission. 1952. "Synthetic Organic Chemicals, United States Production and Sales, 1951." Report No. 175, Second Series. 95p.

US Tariff Commission. 1953. "Synthetic Organic Chemicals, United States Production and Sales, 1952 (Excerpts)." p57, 60-77, 122-125, 132-163.

US Tariff Commission. 1954. "Synthetic Organic Chemicals, United States Production and Sales, 1953." Report No. 194. Second Series. 202p.

US Tariff Commission. 1955. "Synthetic Organic Chemicals, United States Production and Sales , 1954." Report No. 196, Second Series. 204p.

US Tariff Commission. 1956. "Synthetic Organic Chemicals, United States Production and Sales, 1955." Report No. 198, Second Series. 218p.

US Tariff Commission. 1957. "Synthetic Organic Chemicals, United States Production and Sales, 1956 (Excerpts)." Report No. 200, Second Series. p62-81, 128-131, 138-173.

US Tariff Commission. 1958. "Synthetic Organic Chemicals, United States Production and Sales, 1957." Report No. 203, Second Series. 218p.

US Tariff Commission. 1959. "Synthetic Organic Chemicals, United States Production and Sales, 1958 (Excerpts)." Report No. 205, Second Series. p58-77, 122-125, 132-173.

US Tariff Commission. 1960. "Synthetic Organic Chemicals, United States Production and Sales , 1959 (Excerpts)." Report No. 206, Second Series. p1-7, 10-14, 45-46, 50-57, 62-83, 130-131, 140-182.

US Tariff Commission. 1963. "Synthetic Organic Chemicals, United States Production and Sales, 1962 (Excerpts)." TC Publication 114. p64-91, 150-151, 166-221.

US Tariff Commission. 1964. "Synthetic Organic Chemicals, United States Production and Sales, 1963 (Excerpts)." TC Publication 143. p10-13, 44-45, 53-59, 91-115, 152-154, 170-223.

US Tariff Commission. 1965. "Synthetic Organic Chemicals, United States Production and Sales, 1964 (Excerpts)." TC Publication 167. p64-91, 152-155, 172-227.

US Tariff Commission. 1968. "Synthetic Organic Chemicals, United States Production and Sales, 1966 (Excerpts)." TC Publication 248. p65-91, 144-147, 162-213.

Various. 1987-2019. "Spokane stormwater improvements document directory."

Versar, Inc. 1976. "PCBs in the United States: Industrial Use and Environmental Distribution. Task I (Final)." Report to US EPA, Office of Toxic Substances. National Technical Information Service (NTIS) NTIS PB-252012, EPA 560/6-76-005, 494p., February 25.

Vorkamp, K. 2016. "An overlooked environmental issue? A review of the inadvertent formation of PCB-11 and other PCB congeners and their occurrence in consumer products and in the environment." *Sci. Total Environ.* 541:1463-1476. doi: 10.1016/j.scitotenv.2015.10.019.

Washington State Dept. of Ecology (WA Ecology). 1972. Letter to Mayor and Spokane, Washington City Council [re: Notice of violation, Docket No. DE 72-186). 5p., November 10.

Washington State Dept. of Ecology (WA Ecology). 1984. Potential Hazardous Waste Site Preliminary Assessment Summary Memorandum re: General Electric Co. (Spokane Apparatus Service Shop), E. 4323 Mission Avenue, Spokane, WA. 10p., September 7.

Washington State Dept. of Ecology (WA Ecology). 1993. "Final Cleanup Action Plan, Former General Electric Spokane Shop, E. 4323 Mission Avenue, Spokane, WA." Toxics Cleanup Program. 44p., March 29.

Washington State Dept. of Ecology (WA Ecology). 1995. "Department of Ecology 1993-94 Investigation of PCBs in the Spokane River." Publication No. 95-310. 88p., February.

Washington State Dept. of Ecology (WA Ecology). 1996. "Spokane River PCB Source Monitoring Follow-up Study, November and December 1995." Publication No. 96-331. 32p., July.

Washington State Dept. of Ecology (WA Ecology). 2001. "The Use of Sediment Cores to Track Persistent Pollutants in Washington State: A Review." Environmental Assessment Program. Publication No. 01-03-001. 52p., January.

Washington State Dept. of Ecology (WA Ecology). 2002. "Spokane Area Point Source PCB Survey, May 2001." Publication No. 02-03-009. 94p., March.

Washington State Dept. of Ecology (WA Ecology). 2003. "Periodic Review, General Electric/Spokane Site, 1997-2002." 30p., March 20.

Washington State Dept. of Ecology (WA Ecology). 2004. "Draft Cleanup Action Plan, City Parcel Site, Spokane, Washington." Eastern Regional Office, Toxics Cleanup Program. 68p., July.

Washington State Dept. of Ecology (WA Ecology). 2006. "Persistent Organic Pollutants in Feed and Rainbow Trout from Selected Trout Hatcheries." Environmental Assessment Program. Publication No. 06-03-017. 52p., April.

Washington State Dept. of Ecology (WA Ecology). 2008. "Second Periodic Review, General Electric Spokane Site, Spokane, WA." 34p., April.

Washington State Dept. of Ecology (WA Ecology). 2010. "Spokane River and Lake Spokane Dissolved Oxygen Total Maximum Daily Load: Water Quality Improvement Report." Publication No. 07-10-073. 399p., February.

Washington State Dept. of Ecology (WA Ecology). 2011a. "Spokane River PCB Source Assessment, 2003-2007." Publication No. 11-03-013, 156p., April.

Washington State Dept. of Ecology (WA Ecology). 2011b. "National Pollutant Discharge Elimination System Waste Discharge Permit No. WA-002447-3, City of Spokane Riverside Park Water Reclamation Facility and Combined Sewer Overflows (CSOs)." 67p., July 1.

Washington State Dept. of Ecology (WA Ecology). 2012. "Spokane River Urban Waters Source Investigation and Data Analysis Progress Report (2009-2011): Source Tracing for PCB, PBDE, Dioxin/Furan, Lead, Cadmium, and Zinc." Publication No. 12-04-025. 92p.

Washington State Dept. of Ecology (WA Ecology). 2013. "Third Periodic Review (Draft Final), General Electric Spokane Site." 60p., March.

Washington State Dept. of Ecology (WA Ecology). 2014a. "State of Washington Current Water Quality Assessment (2014); 303(d) and 305(b)."

Washington State Dept. of Ecology (WA Ecology). 2014b. "Polychlorinated Biphenyls (PCBs) in General Consumer Products." Publication No. 14-04-035. 64p., June.

Washington State Dept. of Ecology (WA Ecology). 2014c. "Alternatives for Elimination of Polychlorinated Biphenyls (PCBs) in Pigments Used for Printing Inks and Architectural Paints." Publication No. 14-07-005. 39p., February.

Washington State Dept. of Ecology (WA Ecology). 2015a. "Periodic Review: Spokane River Upriver Dam and Donkey Island PCB Sediment Site." 24p., December.

Washington State Dept. of Ecology (WA Ecology). 2015b. "Water Quality Combined Financial Assistance Agreement between the State of Washington Department of Ecology and City of Spokane." WQC-2016-Spokan-00030. 11p., July 1.

Washington State Dept. of Ecology (WA Ecology). 2016a. "Polychlorinated Biphenyls in Consumer Products." Publication no. 16-04-014. 61p., November.

Washington State Dept. of Ecology (WA Ecology). 2016b. "National Pollutant Discharge Elimination System Waste Discharge Permit: City of Spokane Riverside Park Water Reclamation Facility and Combined Sewer Overflows (CSOs), 4401 N. Aubrey L. White Parkway, Spokane, WA (Draft)." Permit No. WA-0024473. 71p., June 30.

Washington State Dept. of Ecology (WA Ecology). 2016c. "Quality Assurance Project Plan: Spokane and Troutlodge Fish Hatchery PCB Evaluation." Publication No. 16-03-104. 45p., March.

Washington State Dept. of Ecology (WA Ecology). 2017a. "Rivers and Watersheds (Washington State)."

Washington State Dept. of Ecology (WA Ecology). 2017b. "Dams (Washington State)."

Washington State Dept. of Ecology (WA Ecology). 2017c. "Tribal Lands (Washington State)."

Washington State Dept. of Ecology (WA Ecology). 2017d. "Administrative order [In the matter of Riverside Park Water Reclamation Facility, 440 I N. Aubrey Parkway, Spokane. WA 99205]." Administrative Order Docket No. 14235. 5p., June 20.

Washington State Dept. of Ecology (WA Ecology). 2017e. "Spokane River and Lake Spokane Dissolved Oxygen Total Maximum Daily Load: 2010-2016 Implementation Report." Water Quality Program. 199p., September.

Washington State Dept. of Ecology (WA Ecology). 2017f. "Environmental Information Management (EIM) database."

Washington State Dept. of Ecology (WA Ecology). 2017g. "Cleanup site search details." Toxics Cleanup Program.

Washington State Dept. of Ecology (WA Ecology). 2017h. "Underground Injection Control (UIC) Database (Version 2.1.0)." Underground Injection Control Program.

Washington State Dept. of Ecology (WA Ecology). 2018. "Water Quality Permitting and Reporting System (PARIS)."

Washington State Dept. of Ecology (WA Ecology). 2019a. "Water quality standards for surface waters of the State of Washington: Toxic substances." WAC 173-201A-240. 8p. Accessed at https://apps.leg.wa.gov/WAC/default.aspx?cite=173-201A-240.

Washington State Dept. of Ecology (WA Ecology). 2019b. "Sediment cleanup levels based on protection of the benthic community in freshwater sediment." WAC 173-204-563. 6p. Accessed on November 11, 2019 at https://apps.leg.wa.gov/WAC/default.aspx?cite=173-204-563.

Washington State Dept. of Ecology (WA Ecology). 2019c. "River & Stream Water Quality Monitoring: Parameter, unit, and data-qualifier descriptions." Accessed at https://fortress.wa.gov/ecy/eap/riverwq/parameters_ref.html.

Washington State Dept. of Ecology (WA Ecology). 2019d. "Eastern Washington Phase II Municipal Stormwater Permit." 57p., July 1.

Washington State Dept. of Ecology (WA Ecology). c. 1991. "Fact Sheet - Application for National Pollutant Discharge Elimination System (NPDES) Permit to Discharge Pollutants to State Waters [Renewal of Permit WA-000095-7]." 36p.

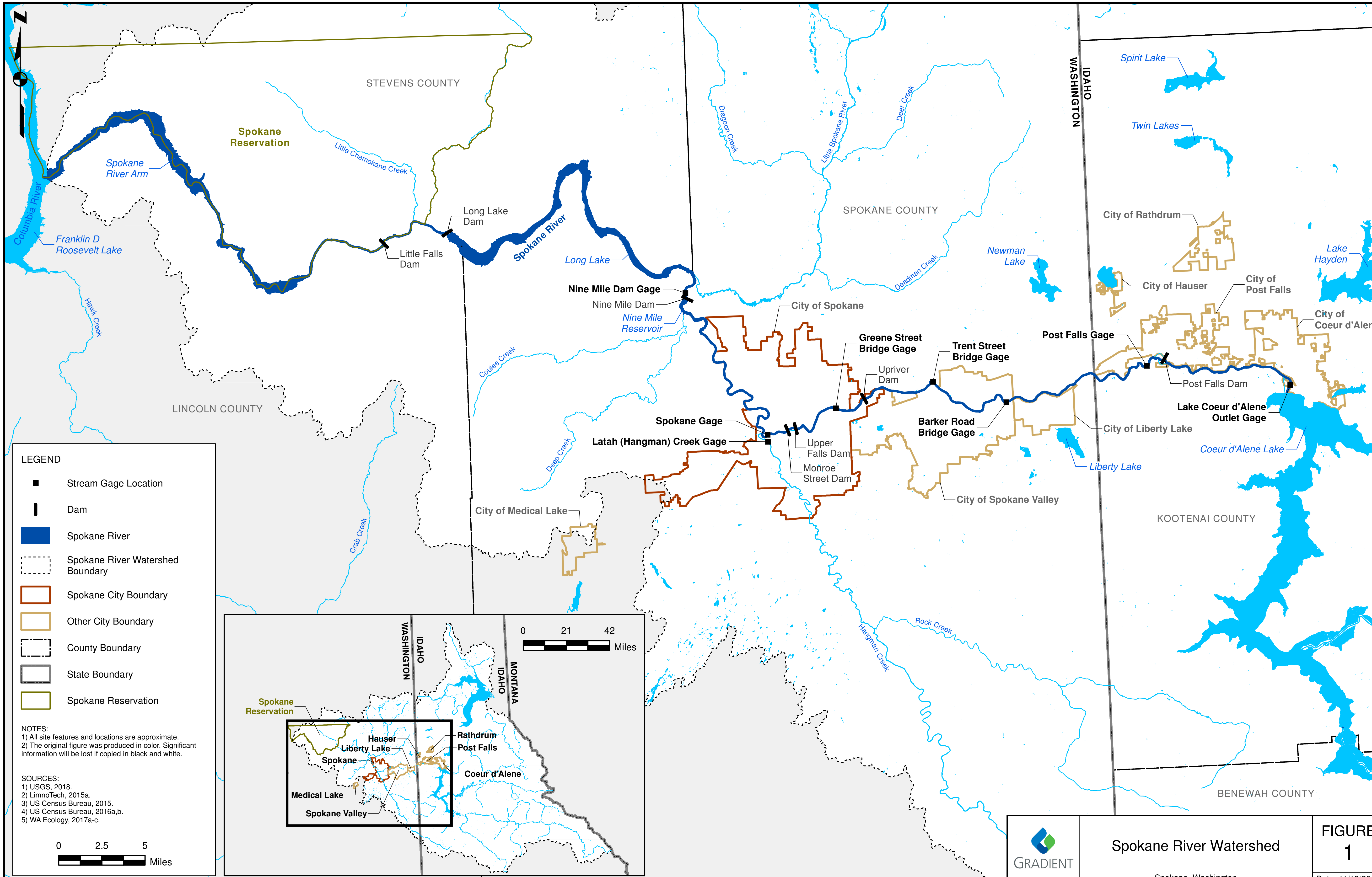
Washington State Dept. of Fish and Wildlife (WDFW). 2018. "Catchable Trout Plant Reports."

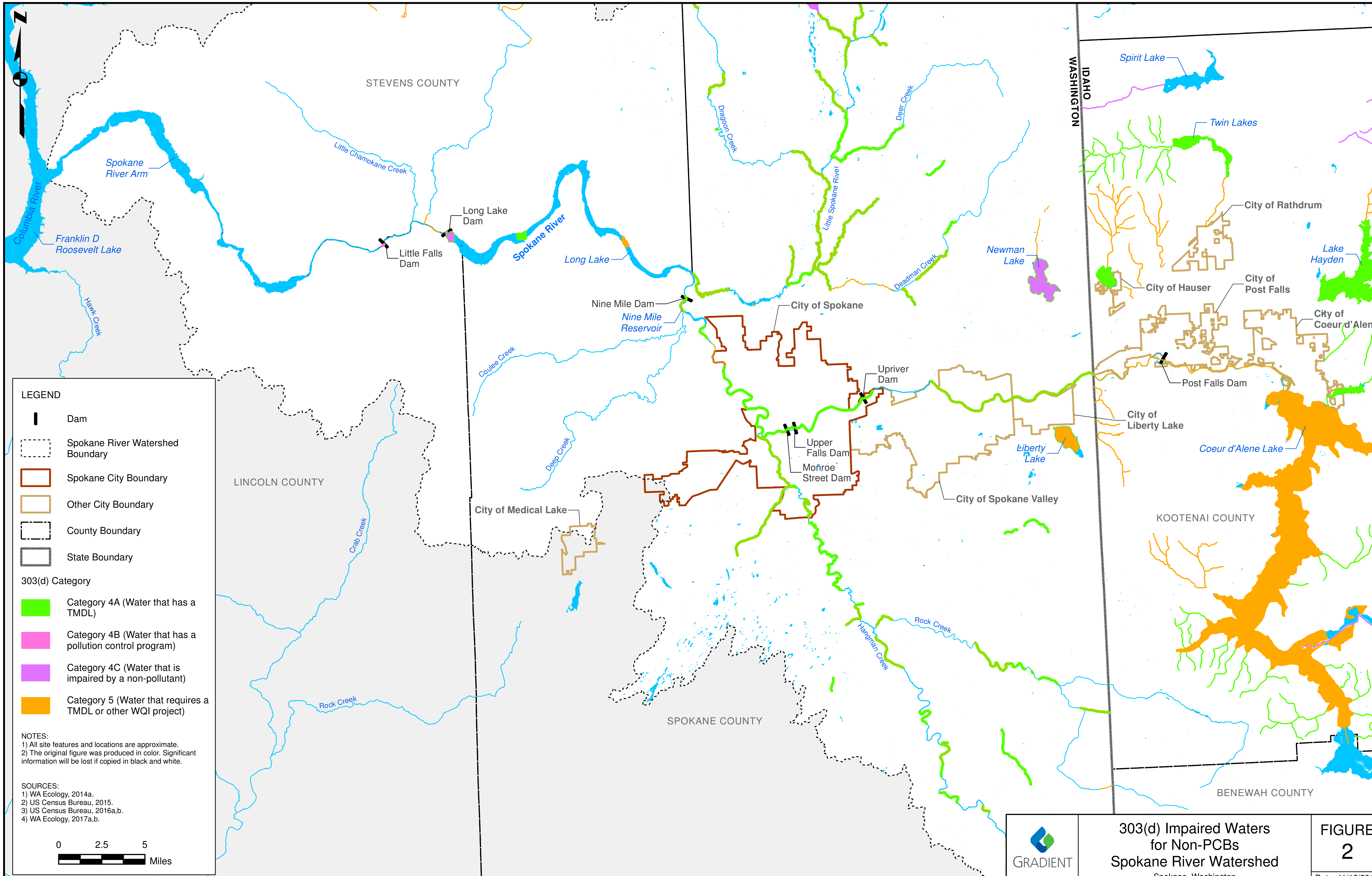
Washington State Legislature. 2014. "Preference - Products and products in packaging that does not contain polychlorinated biphenyls - Limitations - Products and products in packaging containing polychlorinated biphenyls." RCW 39.26.280. Accessed at https://app.leg.wa.gov/rcw/default.aspx?cite=39.26.280.

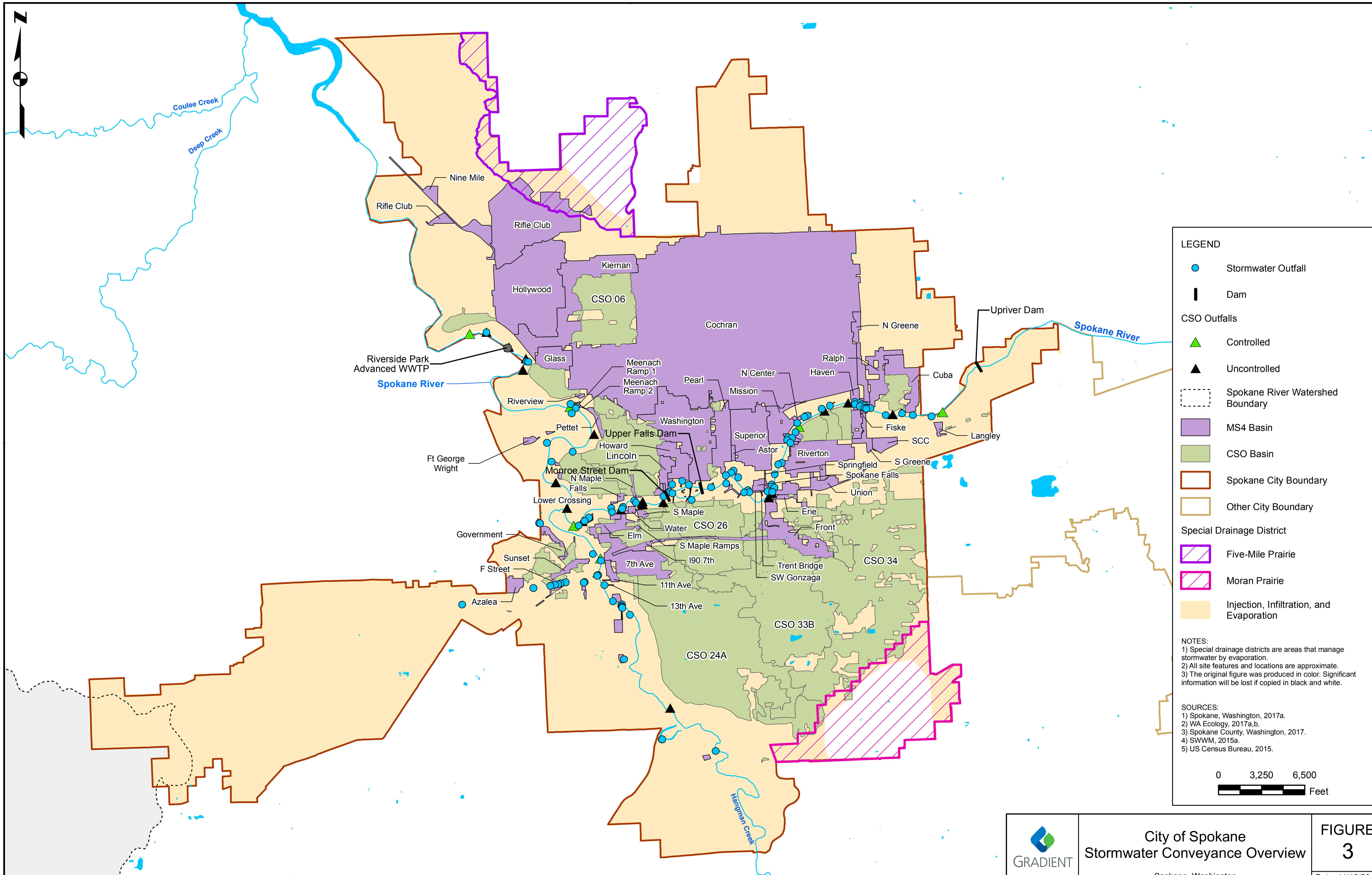
Webb, RG; McCall, A. 1972. "Identities of polychlorinated biphenyl isomers in Aroclors." *J. Assoc. Off. Anal. Chem*. 55(4):746-752.

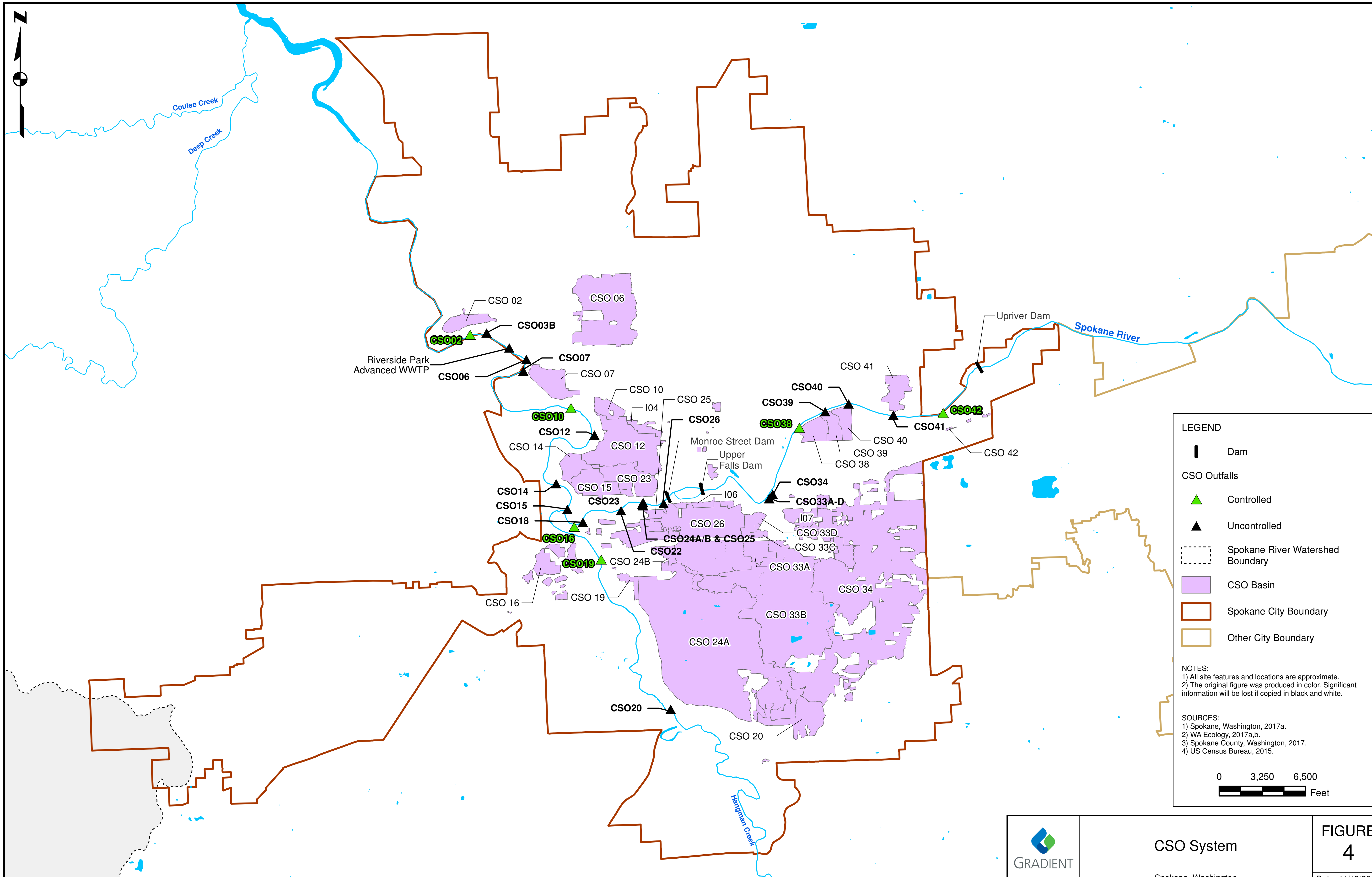
Windsor, SK. [Spokane, Washington]. 2019. "Videotaped 30 (B) 6 deposition of Scott K. Windsor [re: City of Spokane *vs*. Monsanto Co., *et al*.]." Submitted to US District Court, Eastern District of Washington. No. 15-cv-00201-SMJ. 117p., September 13.

Figures

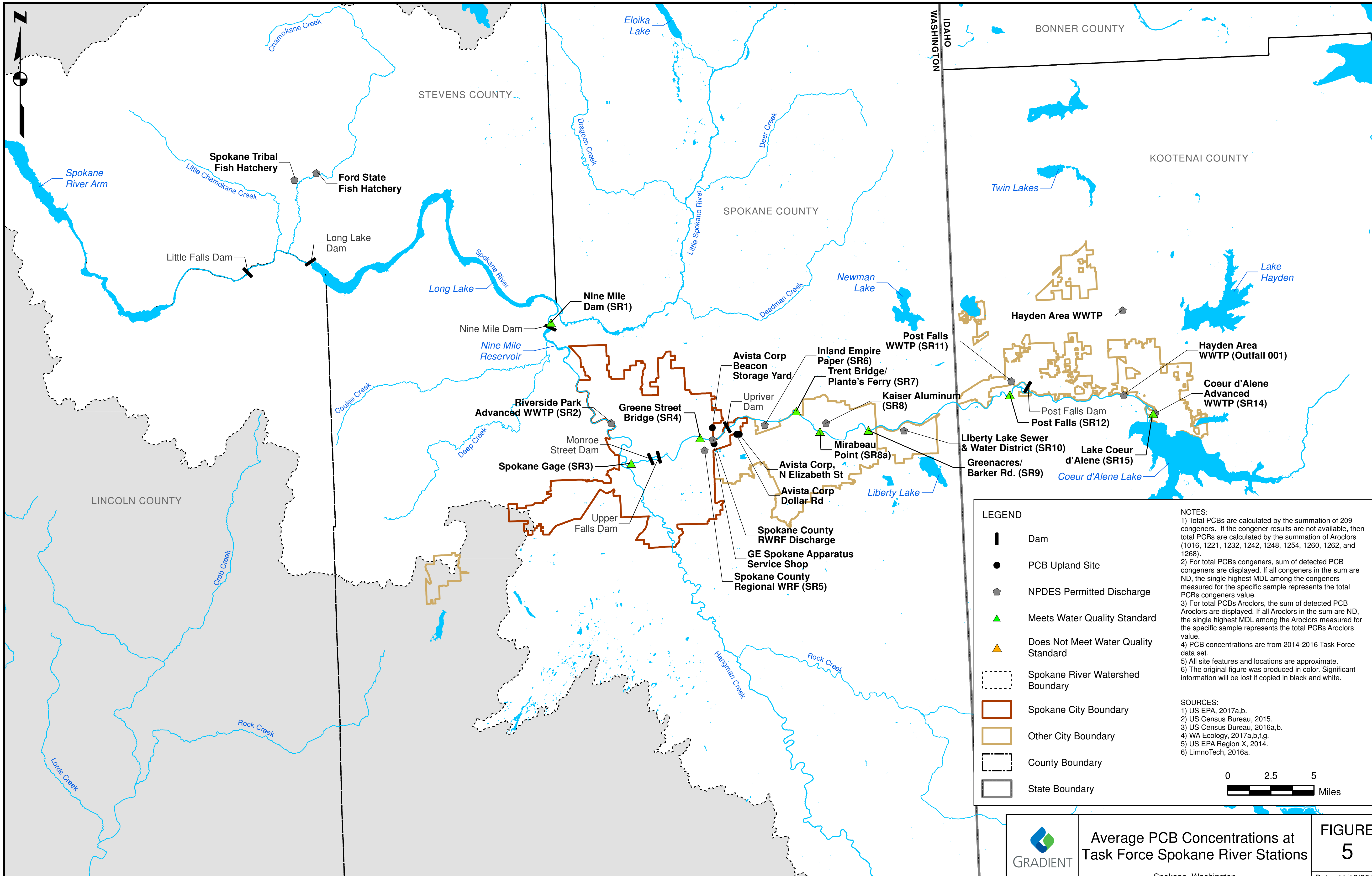

N
STEVENS COUNTY
Spokane Reservation
Little Chamokane Creek
Spokane River Arm
Columbia River
Franklin D Roosevelt Lake
Hawk Creek
Little Falls Dam
Long Lake Dam
Spokane River
Long Lake
Nine Mile Dam Gage
Nine Mile Dam
Nine Mile Reservoir
City of Spokane
Dragoon Creek
Little Spokane River
Deer Creek
Deadman Creek
SPOKANE COUNTY
Newman Lake
WASHINGTON
IDAHO
Spirit Lake
Twin Lakes
City of Rathdrum
City of Hauser
City of Post Falls
Lake Hayden
City of Coeur d'Alene
Post Falls Gage
Post Falls Dam
Greene Street Bridge Gage
Trent Street Bridge Gage
Upriver Dam
Lake Coeur d'Alene Outlet Gage
Barker Road Bridge Gage
City of Liberty Lake
Coeur d'Alene Lake
Liberty Lake
Spokane Gage
Latah (Hangman) Creek Gage
Upper Falls Dam
Monroe Street Dam
City of Spokane Valley
LINCOLN COUNTY
Coulee Creek
Deep Creek
City of Medical Lake
Crab Creek
KOOTENAI COUNTY
Rock Creek
Hangman Creek
BENEWAH COUNTY
LEGEND
Stream Gage Location
Dam
Spokane River
Spokane River Watershed Boundary
Spokane City Boundary
Other City Boundary
County Boundary
State Boundary
Spokane Reservation
NOTES:
1) All site features and locations are approximate.
2) The original figure was produced in color. Significant information will be lost if copied in black and white.
SOURCES:
1) USGS, 2018.
2) LimnoTech, 2015a.
3) US Census Bureau, 2015.
4) US Census Bureau, 2016a,b.
5) WA Ecology, 2017a-c.
0 2.5 5 Miles
0 21 42 Miles
WASHINGTON
IDAHO
MONTANA
Spokane Reservation
Hauser
Liberty Lake
Spokane
Rathdrum
Post Falls
Coeur d'Alene
Medical Lake
Spokane Valley
GRADIENT
Spokane River Watershed
Spokane, Washington
FIGURE 1
Date: 11/13/2019

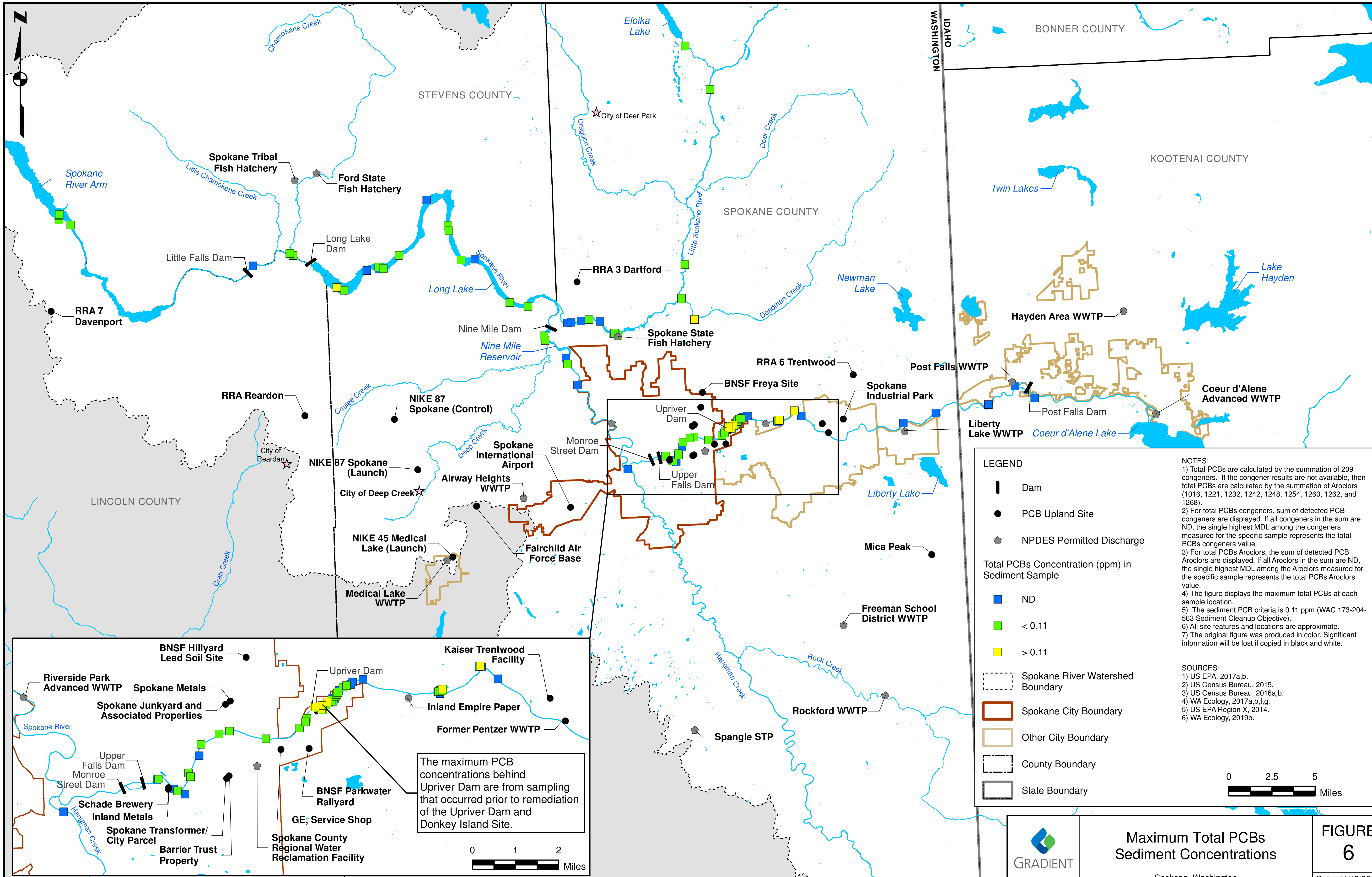

N
STEVENS COUNTY
LINCOLN COUNTY
SPOKANE COUNTY
KOOTENAI COUNTY
BENEWAH COUNTY
IDAHO
WASHINGTON
Spokane River Arm
Columbia River
Franklin D Roosevelt Lake
Hawk Creek
Little Chamokane Creek
Little Falls Dam
Long Lake Dam
Spokane River
Long Lake
Nine Mile Dam
Nine Mile Reservoir
City of Spokane
Dragoon Creek
Little Spokane River
Deer Creek
Deadman Creek
Newman Lake
Coulee Creek
Deep Creek
Crab Creek
Rock Creek
City of Medical Lake
Upriver Dam
Upper Falls Dam
Monroe Street Dam
City of Spokane Valley
Liberty Lake
City of Liberty Lake
Hangman Creek
Spirit Lake
Twin Lakes
City of Rathdrum
City of Hauser
City of Post Falls
Lake Hayden
City of Coeur d'Alene
Post Falls Dam
Coeur d'Alene Lake
LEGEND
Dam
Spokane River Watershed Boundary
Spokane City Boundary
Other City Boundary
County Boundary
State Boundary
303(d) Category
Category 4A (Water that has a TMDL)
Category 4B (Water that has a pollution control program)
Category 4C (Water that is impaired by a non-pollutant)
Category 5 (Water that requires a TMDL or other WQI project)
NOTES:
1) All site features and locations are approximate.
2) The original figure was produced in color. Significant information will be lost if copied in black and white.
SOURCES:
1) WA Ecology, 2014a.
2) US Census Bureau, 2015.
3) US Census Bureau, 2016a,b.
4) WA Ecology, 2017a,b.
0 2.5 5
Miles
GRADIENT
303(d) Impaired Waters for Non-PCBs Spokane River Watershed
Spokane, Washington
FIGURE 2
Date: 11/12/2019

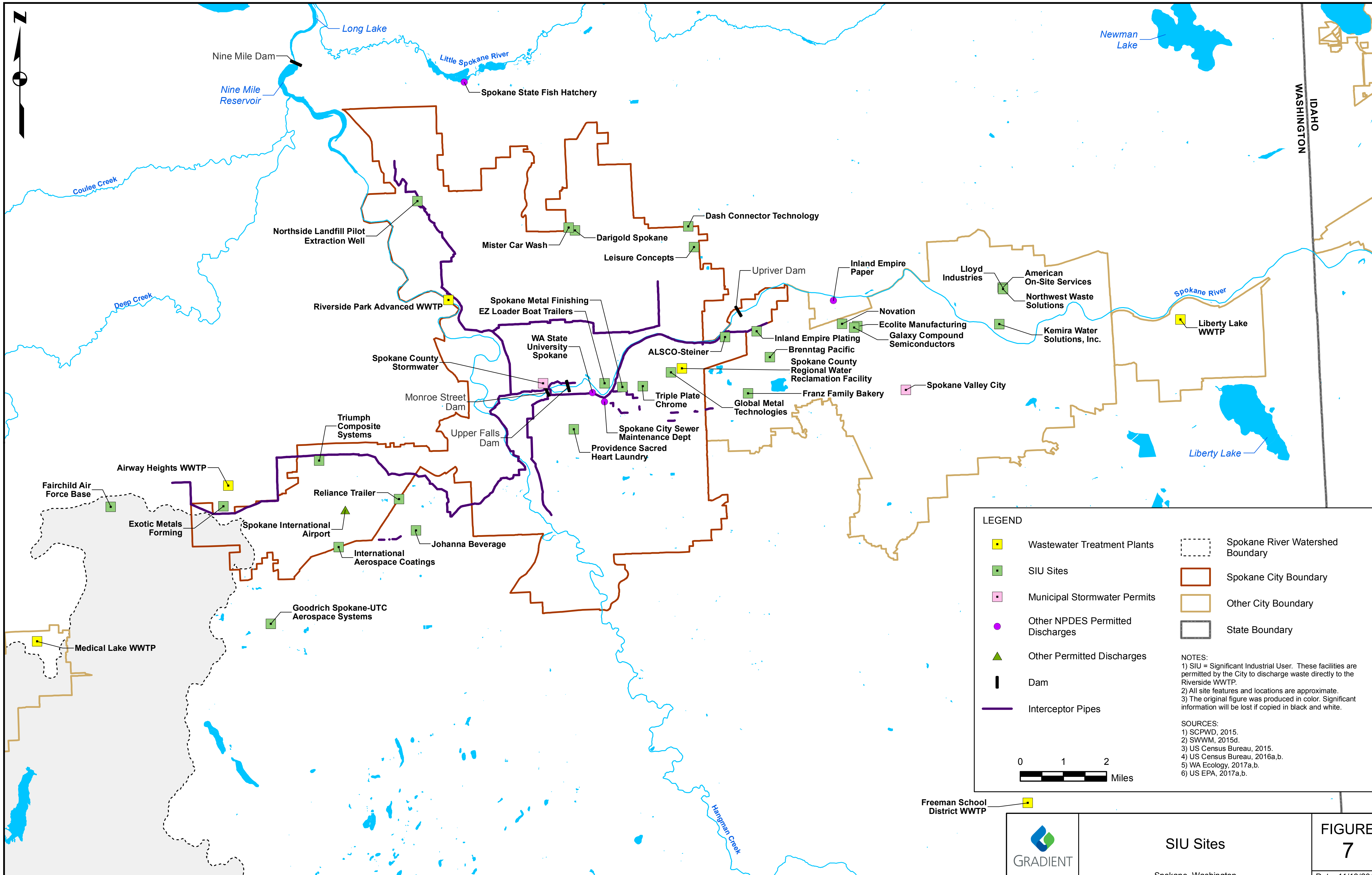

N
Coulee Creek
Deep Creek
Nine Mile
Rifle Club
Rifle Club
Kiernan
Hollywood
CSO 06
Cochran
N Greene
Upriver Dam
Spokane River
Riverside Park Advanced WWTP
Spokane River
Glass
Meenach Ramp 1
Meenach Ramp 2
Pearl
N Center
Ralph
Haven
Cuba
Mission
Riverview
Washington
Fiske
Langley
SCC
Pettet
Upper Falls Dam
Superior
Howard
Astor
Riverton
S Greene
Lincoln
Ft George Wright
Springfield
Spokane Falls
Monroe Street Dam
N Maple
Falls
Union
Lower Crossing
S Maple
Erie
Water
CSO 26
Front
Government
Elm
S Maple Ramps
Sunset
7th Ave
I90 7th
CSO 34
F Street
Trent Bridge
SW Gonzaga
11th Ave
Azalea
13th Ave
CSO 33B
CSO 24A
Hangman Creek
LEGEND
Stormwater Outfall
Dam
CSO Outfalls
Controlled
Uncontrolled
Spokane River Watershed Boundary
MS4 Basin
CSO Basin
Spokane City Boundary
Other City Boundary
Special Drainage District
Five-Mile Prairie
Moran Prairie
Injection, Infiltration, and Evaporation
NOTES:
1) Special drainage districts are areas that manage stormwater by evaporation.
2) All site features and locations are approximate.
3) The original figure was produced in color. Significant information will be lost if copied in black and white.
SOURCES:
1) Spokane, Washington, 2017a.
2) WA Ecology, 2017a,b.
3) Spokane County, Washington, 2017.
4) SWWM, 2015a.
5) US Census Bureau, 2015.
0 3,250 6,500
Feet
GRADIENT
City of Spokane
Stormwater Conveyance Overview
Spokane, Washington
FIGURE
3
Date: 11/12/2019

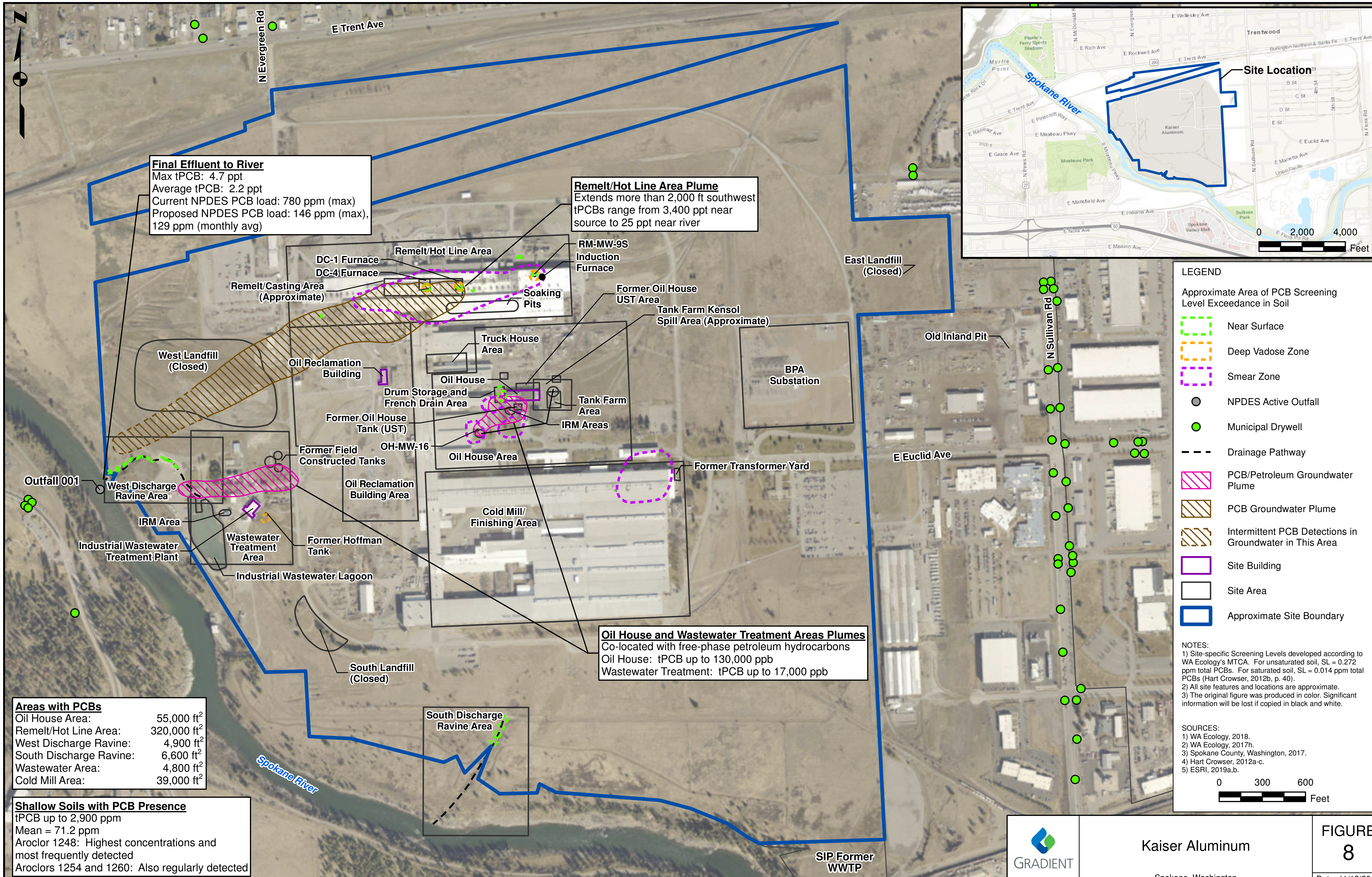


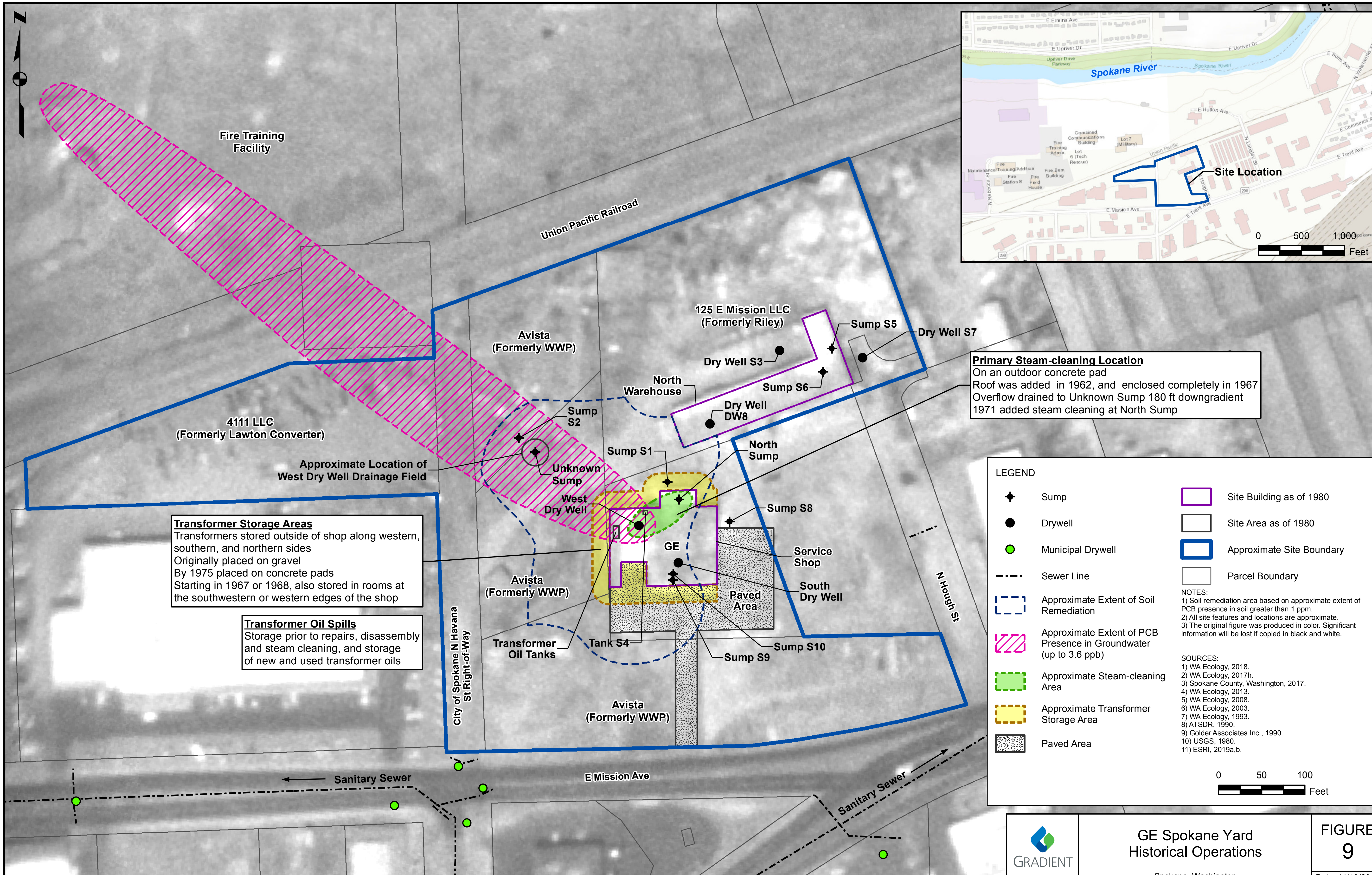
N
Coulee Creek
Deep Creek
Spokane River
Hangman Creek
CSO 02
CSO 06
CSO03B
CSO02
Riverside Park Advanced WWTP
CSO07
CSO06
CSO 07
CSO 10
CSO 25
I04
CSO26
CSO10
CSO12
CSO 14
CSO 12
Monroe Street Dam
Upper Falls Dam
CSO 23
CSO 15
CSO14
CSO15
CSO23
I06
CSO18
CSO 26
CSO16
CSO24A/B & CSO25
CSO22
CSO19
CSO 24B
CSO 16
CSO 19
CSO 24A
CSO20
CSO 20
CSO40
CSO39
CSO38
CSO 41
CSO41
CSO42
Upriver Dam
CSO 40
CSO 39
CSO 38
CSO 42
CSO34
CSO33A-D
I07
CSO 33D
CSO 33C
CSO 33A
CSO 34
CSO 33B
LEGEND
Dam
CSO Outfalls
Controlled
Uncontrolled
Spokane River Watershed Boundary
CSO Basin
Spokane City Boundary
Other City Boundary
NOTES:
1) All site features and locations are approximate.
2) The original figure was produced in color. Significant information will be lost if copied in black and white.
SOURCES:
1) Spokane, Washington, 2017a.
2) WA Ecology, 2017a,b.
3) Spokane County, Washington, 2017.
4) US Census Bureau, 2015.
0 3,250 6,500
Feet
GRADIENT
CSO System
Spokane, Washington
FIGURE 4
Date: 11/12/2019


STEVENS COUNTY
SPOKANE COUNTY
LINCOLN COUNTY
BONNER COUNTY
KOOTENAI COUNTY
WASHINGTON
IDAHO
Chamokane Creek
Eloika Lake
Dragoon Creek
Deer Creek
Little Spokane River
Spokane River Arm
Spokane Tribal Fish Hatchery
Ford State Fish Hatchery
Little Chamokane Creek
Little Falls Dam
Long Lake Dam
Spokane River
Long Lake
Nine Mile Dam (SR1)
Nine Mile Dam
Nine Mile Reservoir
Deadman Creek
Newman Lake
Twin Lakes
Lake Hayden
Hayden Area WWTP
Post Falls WWTP (SR11)
Hayden Area WWTP (Outfall 001)
Coeur d'Alene Advanced WWTP (SR14)
Avista Corp Beacon Storage Yard
Inland Empire Paper (SR6)
Trent Bridge/ Plante's Ferry (SR7)
Upriver Dam
Kaiser Aluminum (SR8)
Post Falls Dam
Post Falls (SR12)
Riverside Park Advanced WWTP (SR2)
Greene Street Bridge (SR4)
Coulee Creek
Deep Creek
Monroe Street Dam
Spokane Gage (SR3)
Mirabeau Point (SR8a)
Liberty Lake Sewer & Water District (SR10)
Lake Coeur d'Alene (SR15)
Greenacres/ Barker Rd. (SR9)
Coeur d'Alene Lake
Avista Corp, N Elizabeth St
Avista Corp Dollar Rd
Liberty Lake
Upper Falls Dam
Spokane County RWRF Discharge
GE Spokane Apparatus Service Shop
Spokane County Regional WRF (SR5)
Crab Creek
Rock Creek
Hangman Creek
Lords Creek
LEGEND
Dam
PCB Upland Site
NPDES Permitted Discharge
Meets Water Quality Standard
Does Not Meet Water Quality Standard
Spokane River Watershed Boundary
Spokane City Boundary
Other City Boundary
County Boundary
State Boundary
NOTES:
1) Total PCBs are calculated by the summation of 209 congeners. If the congener results are not available, then total PCBs are calculated by the summation of Aroclors (1016, 1221, 1232, 1242, 1248, 1254, 1260, 1262, and 1268).
2) For total PCBs congeners, sum of detected PCB congeners are displayed. If all congeners in the sum are ND, the single highest MDL among the congeners measured for the specific sample represents the total PCBs congeners value.
3) For total PCBs Aroclors, the sum of detected PCB Aroclors are displayed. If all Aroclors in the sum are ND, the single highest MDL among the Aroclors measured for the specific sample represents the total PCBs Aroclors value.
4) PCB concentrations are from 2014-2016 Task Force data set.
5) All site features and locations are approximate.
6) The original figure was produced in color. Significant information will be lost if copied in black and white.
SOURCES:
1) US EPA, 2017a,b.
2) US Census Bureau, 2015.
3) US Census Bureau, 2016a,b.
4) WA Ecology, 2017a,b,f,g.
5) US EPA Region X, 2014.
6) LimnoTech, 2016a.
0 2.5 5 Miles
GRADIENT
Average PCB Concentrations at Task Force Spokane River Stations
Spokane, Washington
FIGURE 5
Date: 11/13/2019

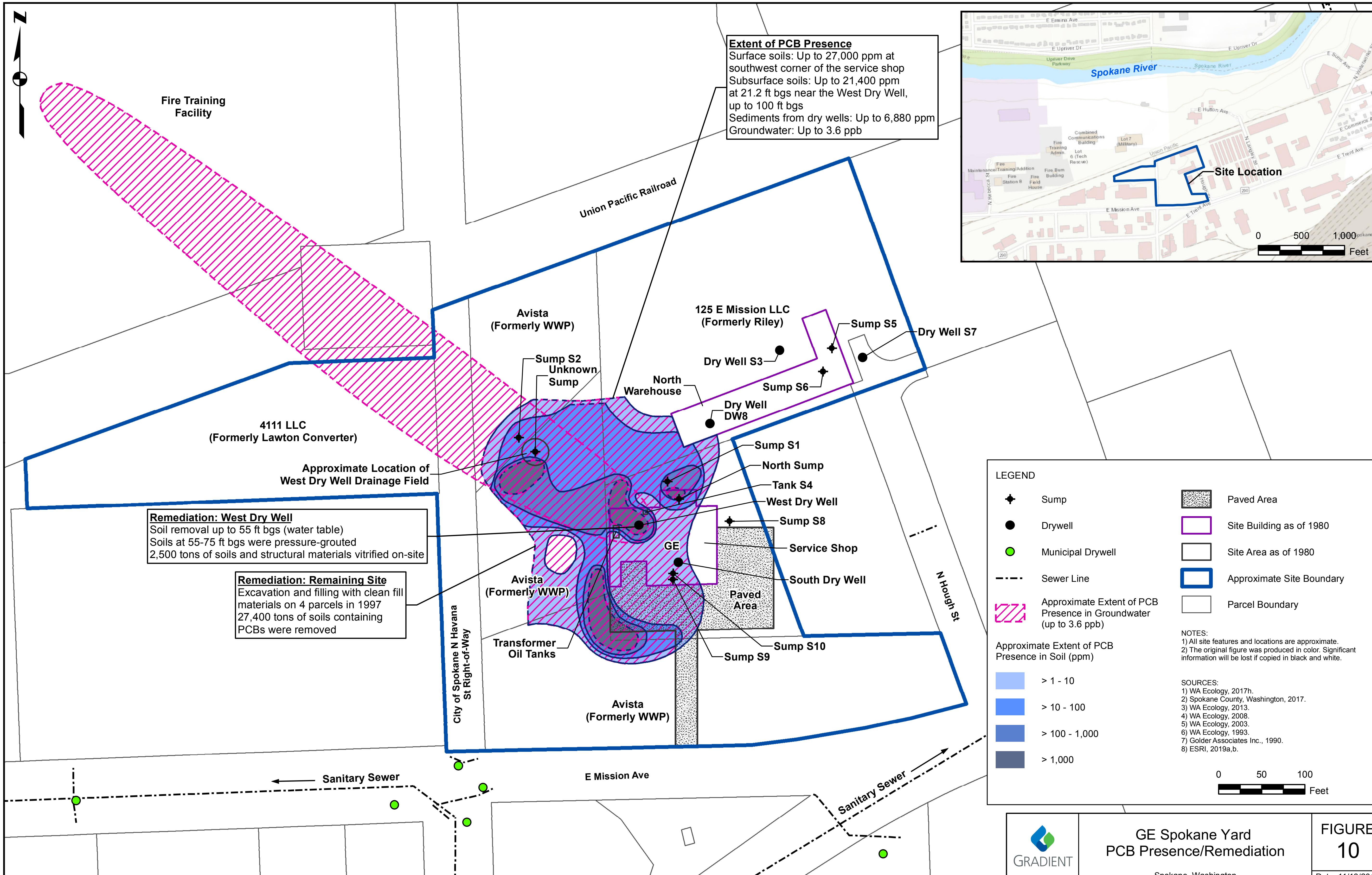

N
STEVENS COUNTY
SPOKANE COUNTY
LINCOLN COUNTY
BONNER COUNTY
KOOTENAI COUNTY
WASHINGTON
IDAHO
Chamokane Creek
Spokane River Arm
Spokane Tribal Fish Hatchery
Ford State Fish Hatchery
Little Chamokane Creek
Little Falls Dam
Long Lake Dam
Long Lake
Spokane River
RRA 7 Davenport
Nine Mile Dam
Nine Mile Reservoir
Spokane State Fish Hatchery
RRA 3 Dartford
Eloika Lake
City of Deer Park
Dragoon Creek
Deer Creek
Little Spokane River
Deadman Creek
Newman Lake
RRA 6 Trentwood
BNSF Freya Site
Spokane Industrial Park
Post Falls WWTP
Post Falls Dam
Hayden Area WWTP
Lake Hayden
Twin Lakes
Coeur d'Alene Advanced WWTP
Coeur d'Alene Lake
Liberty Lake WWTP
Liberty Lake
RRA Reardon
City of Reardan
Coulee Creek
NIKE 87 Spokane (Control)
NIKE 87 Spokane (Launch)
City of Deep Creek
Deep Creek
Spokane International Airport
Airway Heights WWTP
Monroe Street Dam
Upriver Dam
Upper Falls Dam
NIKE 45 Medical Lake (Launch)
Fairchild Air Force Base
Medical Lake WWTP
Crab Creek
Mica Peak
Freeman School District WWTP
Rock Creek
Hangman Creek
Rockford WWTP
Spangle STP
BNSF Hillyard Lead Soil Site
Riverside Park Advanced WWTP
Spokane Metals
Spokane Junkyard and Associated Properties
Upriver Dam
Kaiser Trentwood Facility
Inland Empire Paper
Former Pentzer WWTP
Spokane River
Upper Falls Dam
Monroe Street Dam
Schade Brewery
Inland Metals
Spokane Transformer/ City Parcel
Barrier Trust Property
Spokane County Regional Water Reclamation Facility
BNSF Parkwater Railyard
GE, Service Shop
Hangman Creek
The maximum PCB concentrations behind Upriver Dam are from sampling that occurred prior to remediation of the Upriver Dam and Donkey Island Site.
0 1 2 Miles
LEGEND
Dam
PCB Upland Site
NPDES Permitted Discharge
Total PCBs Concentration (ppm) in Sediment Sample
ND
< 0.11
> 0.11
Spokane River Watershed Boundary
Spokane City Boundary
Other City Boundary
County Boundary
State Boundary
NOTES:
1) Total PCBs are calculated by the summation of 209 congeners. If the congener results are not available, then total PCBs are calculated by the summation of Aroclors (1016, 1221, 1232, 1242, 1248, 1254, 1260, 1262, and 1268).
2) For total PCBs congeners, sum of detected PCB congeners are displayed. If all congeners in the sum are ND, the single highest MDL among the congeners measured for the specific sample represents the total PCBs congeners value.
3) For total PCBs Aroclors, the sum of detected PCB Aroclors are displayed. If all Aroclors in the sum are ND, the single highest MDL among the Aroclors measured for the specific sample represents the total PCBs Aroclors value.
4) The figure displays the maximum total PCBs at each sample location.
5) The sediment PCB criteria is 0.11 ppm (WAC 173-204-563 Sediment Cleanup Objective).
6) All site features and locations are approximate.
7) The original figure was produced in color. Significant information will be lost if copied in black and white.
SOURCES:
1) US EPA, 2017a,b.
2) US Census Bureau, 2015.
3) US Census Bureau, 2016a,b.
4) WA Ecology, 2017a,b,f,g.
5) US EPA Region X, 2014.
6) WA Ecology, 2019b.
0 2.5 5 Miles
GRADIENT
Maximum Total PCBs Sediment Concentrations
Spokane, Washington
FIGURE 6
Date: 11/13/2019


Long Lake
Nine Mile Dam
Little Spokane River
Nine Mile Reservoir
Spokane State Fish Hatchery
Newman Lake
WASHINGTON
IDAHO
Coulee Creek
Northside Landfill Pilot Extraction Well
Mister Car Wash
Darigold Spokane
Dash Connector Technology
Leisure Concepts
Deep Creek
Riverside Park Advanced WWTP
Spokane Metal Finishing
EZ Loader Boat Trailers
Upriver Dam
Inland Empire Paper
Lloyd Industries
American On-Site Services
Northwest Waste Solutions
Spokane River
Novation
Ecolite Manufacturing
Galaxy Compound Semiconductors
Inland Empire Plating
Brenntag Pacific
Kemira Water Solutions, Inc.
Liberty Lake WWTP
WA State University Spokane
Spokane County Stormwater
ALSCO-Steiner
Spokane County Regional Water Reclamation Facility
Spokane Valley City
Franz Family Bakery
Monroe Street Dam
Triple Plate Chrome
Global Metal Technologies
Triumph Composite Systems
Upper Falls Dam
Spokane City Sewer Maintenance Dept
Providence Sacred Heart Laundry
Liberty Lake
Airway Heights WWTP
Fairchild Air Force Base
Reliance Trailer
Exotic Metals Forming
Spokane International Airport
Johanna Beverage
International Aerospace Coatings
Goodrich Spokane-UTC Aerospace Systems
Medical Lake WWTP
Hangman Creek
Freeman School District WWTP
LEGEND
Wastewater Treatment Plants
SIU Sites
Municipal Stormwater Permits
Other NPDES Permitted Discharges
Other Permitted Discharges
Dam
Interceptor Pipes
Spokane River Watershed Boundary
Spokane City Boundary
Other City Boundary
State Boundary
NOTES:
1) SIU = Significant Industrial User. These facilities are permitted by the City to discharge waste directly to the Riverside WWTP.
2) All site features and locations are approximate.
3) The original figure was produced in color. Significant information will be lost if copied in black and white.
SOURCES:
1) SCPWD, 2015.
2) SWWM, 2015d.
3) US Census Bureau, 2015.
4) US Census Bureau, 2016a,b.
5) WA Ecology, 2017a,b.
6) US EPA, 2017a,b.
0 1 2
Miles
GRADIENT
SIU Sites
Spokane, Washington
FIGURE 7
Date: 11/13/2019


E Trent Ave
N Evergreen Rd
Final Effluent to River
Max tPCB: 4.7 ppt
Average tPCB: 2.2 ppt
Current NPDES PCB load: 780 ppm (max)
Proposed NPDES PCB load: 146 ppm (max), 129 ppm (monthly avg)
Remelt/Hot Line Area Plume
Extends more than 2,000 ft southwest
tPCBs range from 3,400 ppt near source to 25 ppt near river
Remelt/Hot Line Area
RM-MW-9S
Induction Furnace
DC-1 Furnace
DC-4 Furnace
Remelt/Casting Area (Approximate)
Soaking Pits
Former Oil House UST Area
Tank Farm Kensol Spill Area (Approximate)
East Landfill (Closed)
Old Inland Pit
N Sullivan Rd
West Landfill (Closed)
Oil Reclamation Building
Truck House Area
Oil House
Drum Storage and French Drain Area
Tank Farm Area
Former Oil House Tank (UST)
IRM Areas
OH-MW-16
Oil House Area
BPA Substation
Former Field Constructed Tanks
Former Transformer Yard
E Euclid Ave
Outfall 001
West Discharge Ravine Area
Oil Reclamation Building Area
Cold Mill/ Finishing Area
IRM Area
Industrial Wastewater Treatment Plant
Wastewater Treatment Area
Former Hoffman Tank
Industrial Wastewater Lagoon
Oil House and Wastewater Treatment Areas Plumes
Co-located with free-phase petroleum hydrocarbons
Oil House: tPCB up to 130,000 ppb
Wastewater Treatment: tPCB up to 17,000 ppb
South Landfill (Closed)
South Discharge Ravine Area
Spokane River
SIP Former WWTP
Areas with PCBs
Oil House Area: 55,000 ft²
Remelt/Hot Line Area: 320,000 ft²
West Discharge Ravine: 4,900 ft²
South Discharge Ravine: 6,600 ft²
Wastewater Area: 4,800 ft²
Cold Mill Area: 39,000 ft²
Shallow Soils with PCB Presence
tPCB up to 2,900 ppm
Mean = 71.2 ppm
Aroclor 1248: Highest concentrations and most frequently detected
Aroclors 1254 and 1260: Also regularly detected
Site Location
Spokane River
Trentwood
0 2,000 4,000 Feet
LEGEND
Approximate Area of PCB Screening Level Exceedance in Soil
Near Surface
Deep Vadose Zone
Smear Zone
NPDES Active Outfall
Municipal Drywell
Drainage Pathway
PCB/Petroleum Groundwater Plume
PCB Groundwater Plume
Intermittent PCB Detections in Groundwater in This Area
Site Building
Site Area
Approximate Site Boundary
NOTES:
1) Site-specific Screening Levels developed according to WA Ecology's MTCA. For unsaturated soil, SL = 0.272 ppm total PCBs. For saturated soil, SL = 0.014 ppm total PCBs (Hart Crowser, 2012b, p. 40).
2) All site features and locations are approximate.
3) The original figure was produced in color. Significant information will be lost if copied in black and white.
SOURCES:
1) WA Ecology, 2018.
2) WA Ecology, 2017h.
3) Spokane County, Washington, 2017.
4) Hart Crowser, 2012a-c.
5) ESRI, 2019a,b.
0 300 600 Feet
GRADIENT
Kaiser Aluminum
Spokane, Washington
FIGURE 8
Date: 11/13/2019

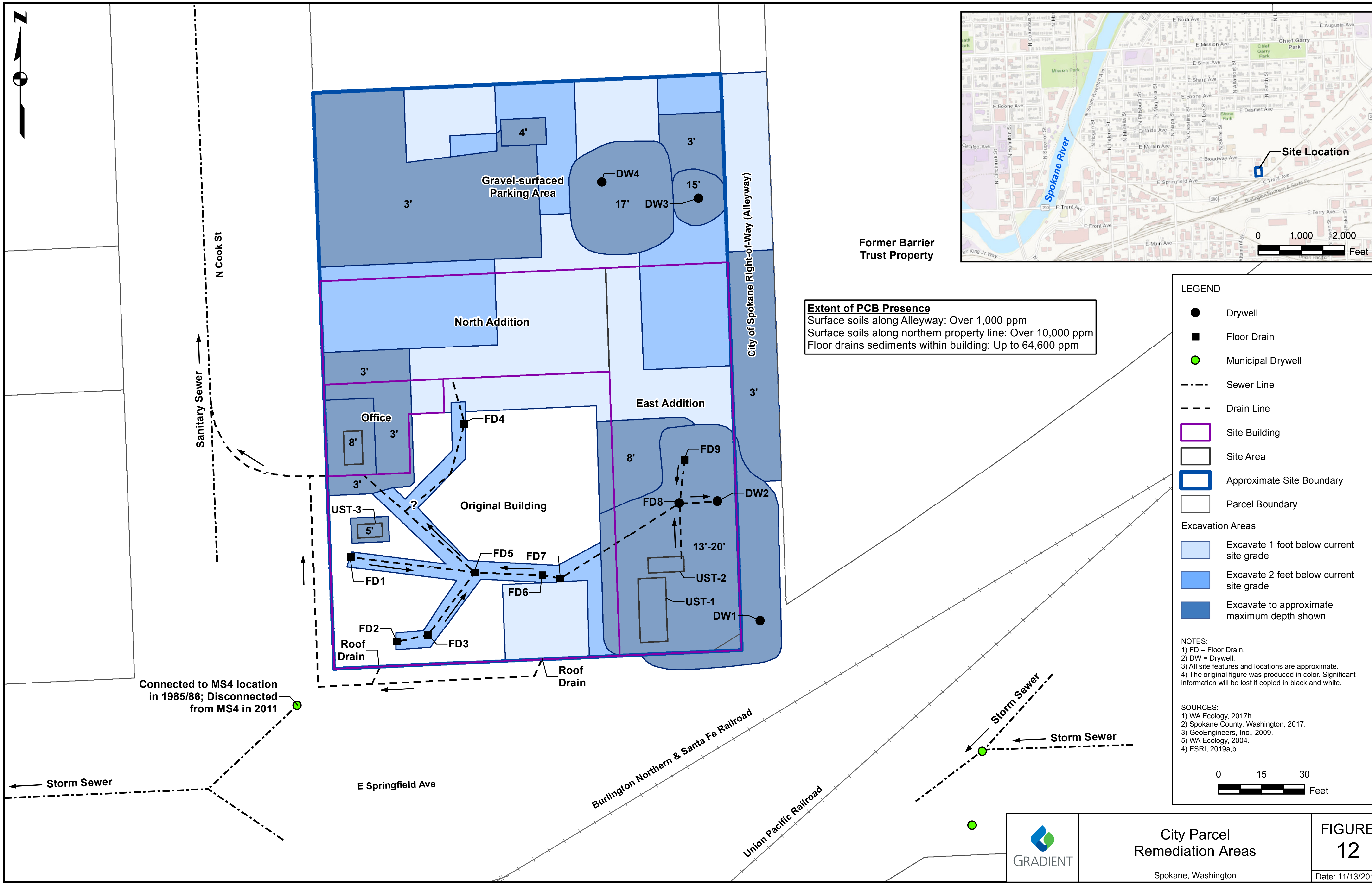


Fire Training Facility
Union Pacific Railroad
Avista (Formerly WWP)
125 E Mission LLC (Formerly Riley)
Sump S5
Dry Well S7
Dry Well S3
Sump S6
North Warehouse
Dry Well DW8
4111 LLC (Formerly Lawton Converter)
Sump S2
Approximate Location of West Dry Well Drainage Field
Unknown Sump
Sump S1
North Sump
West Dry Well
GE
Sump S8
Service Shop
South Dry Well
Paved Area
Primary Steam-cleaning Location
On an outdoor concrete pad
Roof was added in 1962, and enclosed completely in 1967
Overflow drained to Unknown Sump 180 ft downgradient
1971 added steam cleaning at North Sump
Transformer Storage Areas
Transformers stored outside of shop along western, southern, and northern sides
Originally placed on gravel
By 1975 placed on concrete pads
Starting in 1967 or 1968, also stored in rooms at the southwestern or western edges of the shop
Transformer Oil Spills
Storage prior to repairs, disassembly and steam cleaning, and storage of new and used transformer oils
Avista (Formerly WWP)
Transformer Oil Tanks
Tank S4
Sump S9
Sump S10
City of Spokane N Havana St Right-of-Way
Avista (Formerly WWP)
N Hough St
Sanitary Sewer
E Mission Ave
Sanitary Sewer
Spokane River
Site Location
0 500 1,000 Feet
LEGEND
Sump
Drywell
Municipal Drywell
Sewer Line
Approximate Extent of Soil Remediation
Approximate Extent of PCB Presence in Groundwater (up to 3.6 ppb)
Approximate Steam-cleaning Area
Approximate Transformer Storage Area
Paved Area
Site Building as of 1980
Site Area as of 1980
Approximate Site Boundary
Parcel Boundary
NOTES:
1) Soil remediation area based on approximate extent of PCB presence in soil greater than 1 ppm.
2) All site features and locations are approximate.
3) The original figure was produced in color. Significant information will be lost if copied in black and white.
SOURCES:
1) WA Ecology, 2018.
2) WA Ecology, 2017h.
3) Spokane County, Washington, 2017.
4) WA Ecology, 2013.
5) WA Ecology, 2008.
6) WA Ecology, 2003.
7) WA Ecology, 1993.
8) ATSDR, 1990.
9) Golder Associates Inc., 1990.
10) USGS, 1980.
11) ESRI, 2019a,b.
0 50 100 Feet
GRADIENT
GE Spokane Yard Historical Operations
Spokane, Washington
FIGURE 9
Date: 11/13/2019

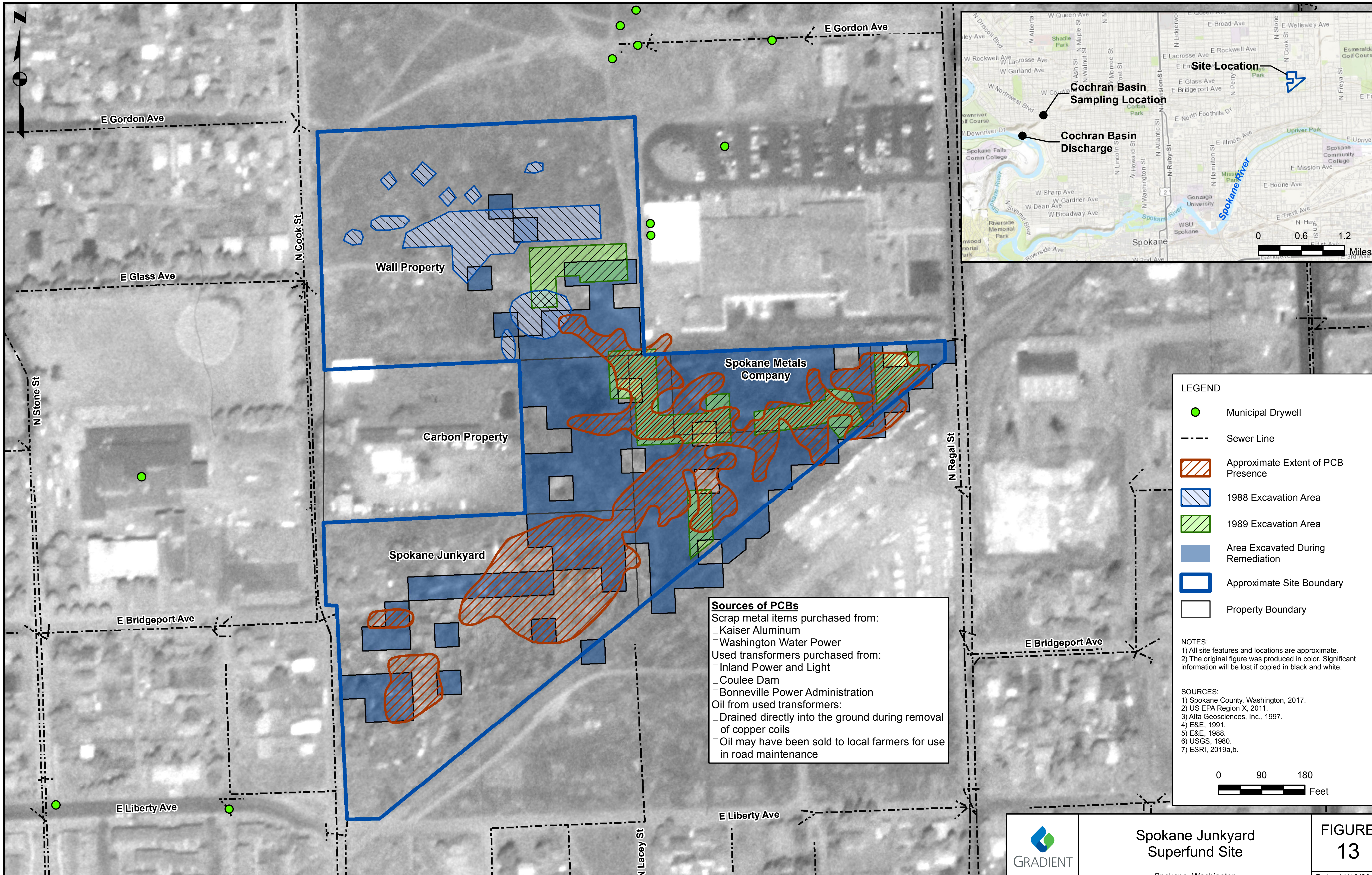


Extent of PCB Presence
Surface soils: Up to 27,000 ppm at southwest corner of the service shop
Subsurface soils: Up to 21,400 ppm at 21.2 ft bgs near the West Dry Well, up to 100 ft bgs
Sediments from dry wells: Up to 6,880 ppm
Groundwater: Up to 3.6 ppb
Fire Training Facility
Union Pacific Railroad
Spokane River
Site Location
0 500 1,000 Feet
Avista (Formerly WWP)
125 E Mission LLC (Formerly Riley)
Sump S5
Dry Well S7
Sump S2
Unknown Sump
Dry Well S3
North Warehouse
Sump S6
Dry Well DW8
4111 LLC (Formerly Lawton Converter)
Sump S1
North Sump
Approximate Location of West Dry Well Drainage Field
Tank S4
West Dry Well
Sump S8
Remediation: West Dry Well
Soil removal up to 55 ft bgs (water table)
Soils at 55-75 ft bgs were pressure-grouted
2,500 tons of soils and structural materials vitrified on-site
GE
Service Shop
Remediation: Remaining Site
Excavation and filling with clean fill materials on 4 parcels in 1997
27,400 tons of soils containing PCBs were removed
Avista (Formerly WWP)
South Dry Well
Paved Area
N Hough St
City of Spokane N Havana St Right-of-Way
Transformer Oil Tanks
Sump S10
Sump S9
Avista (Formerly WWP)
Sanitary Sewer
E Mission Ave
Sanitary Sewer
LEGEND
Sump
Drywell
Municipal Drywell
Sewer Line
Approximate Extent of PCB Presence in Groundwater (up to 3.6 ppb)
Approximate Extent of PCB Presence in Soil (ppm)
> 1 - 10
> 10 - 100
> 100 - 1,000
> 1,000
Paved Area
Site Building as of 1980
Site Area as of 1980
Approximate Site Boundary
Parcel Boundary
NOTES:
1) All site features and locations are approximate.
2) The original figure was produced in color. Significant information will be lost if copied in black and white.
SOURCES:
1) WA Ecology, 2017h.
2) Spokane County, Washington, 2017.
3) WA Ecology, 2013.
4) WA Ecology, 2008.
5) WA Ecology, 2003.
6) WA Ecology, 1993.
7) Golder Associates Inc., 1990.
8) ESRI, 2019a,b.
0 50 100 Feet
GRADIENT
GE Spokane Yard
PCB Presence/Remediation
Spokane, Washington
FIGURE 10
Date: 11/13/2019

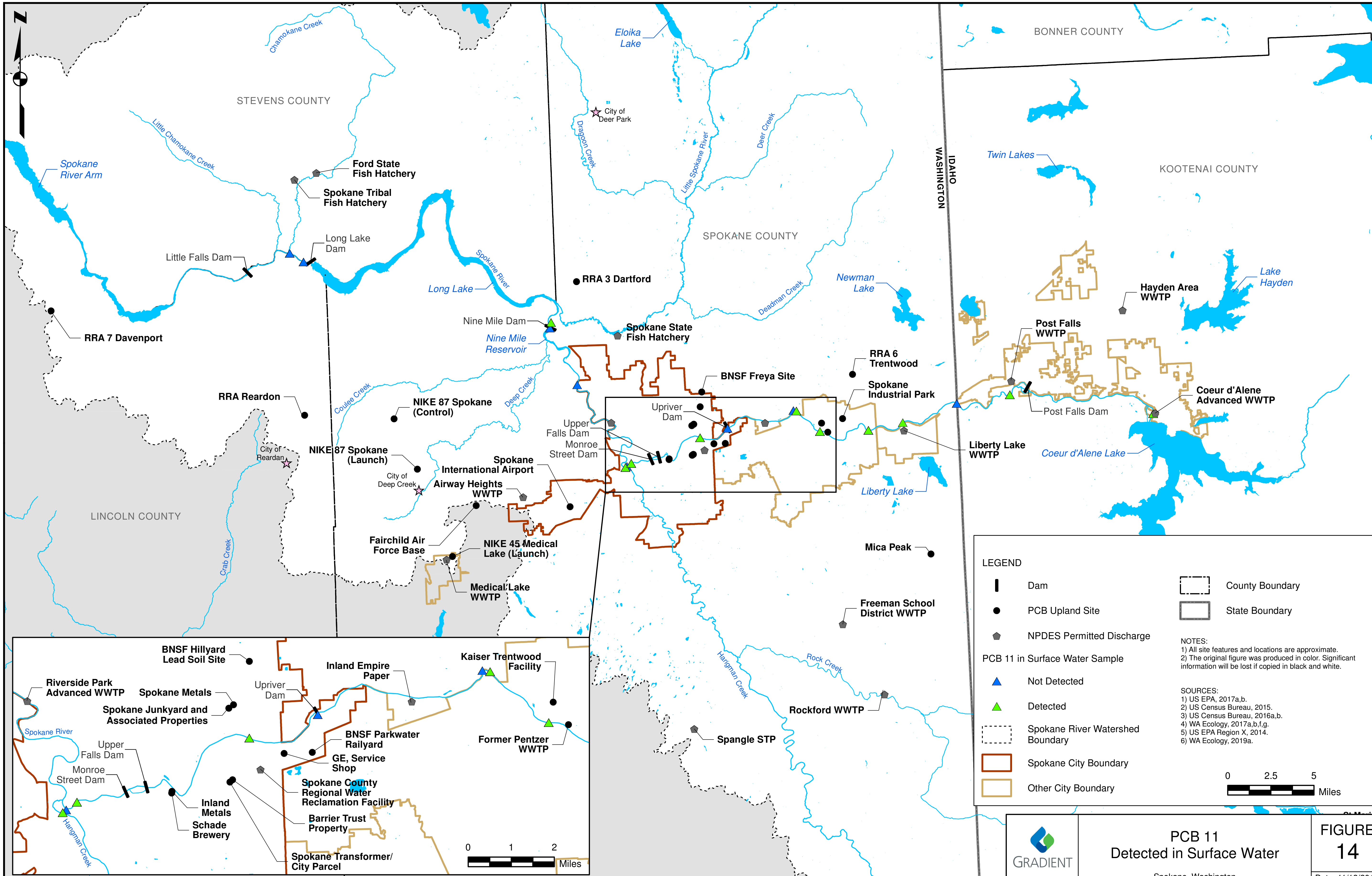

N
Gravel-surfaced Parking Area
DW4
DW3
North Addition
East Addition
Office
FD4
FD9
FD8
DW2
UST-3
?
Original Building
FD5
FD7
FD1
FD6
UST-2
UST-1
DW1
FD2
FD3
Roof Drain
Roof Drain
N Cook St
Sanitary Sewer
City of Spokane Right-of-Way (Alleyway)
Former Barrier Trust Property
Connected to MS4 location in 1985/86; Disconnected from MS4 in 2011
Storm Sewer
E Springfield Ave
Burlington Northern & Santa Fe Railroad
Union Pacific Railroad
Storm Sewer
Storm Sewer
Site Location
Spokane River
0 1,000 2,000 Feet
LEGEND
Drywell
Floor Drain
Municipal Drywell
Sewer Line
Drainage Pathway
Site Building
Site Area
Approximate Site Boundary
Parcel Boundary
NOTES:
1) FD = Floor Drain.
2) DW = Drywell.
3) All site features and locations are approximate.
4) The original figure was produced in color. Significant information will be lost if copied in black and white.
SOURCES:
1) WA Ecology, 2017h.
2) Spokane County, Washington, 2017.
3) GeoEngineers, Inc., 2009.
4) SURDEX Corp., 2007.
5) WA Ecology, 2004.
6) ESRI, 2019a,b.
0 15 30 Feet
GRADIENT
City Parcel Historical Operations
Spokane, Washington
FIGURE 11
Date: 11/13/2019



Gravel-surfaced Parking Area
4'
3'
DW4
15'
17'
DW3
N Cook St
City of Spokane Right-of-Way (Alleyway)
Former Barrier Trust Property
North Addition
Sanitary Sewer
Office
8'
East Addition
FD4
FD9
DW2
FD8
UST-3
5'
Original Building
13'-20'
FD5
FD7
FD1
FD6
UST-2
UST-1
DW1
FD2
FD3
Roof Drain
Connected to MS4 location in 1985/86; Disconnected from MS4 in 2011
Storm Sewer
E Springfield Ave
Burlington Northern & Santa Fe Railroad
Union Pacific Railroad
Site Location
Spokane River
0 1,000 2,000 Feet
Extent of PCB Presence
Surface soils along Alleyway: Over 1,000 ppm
Surface soils along northern property line: Over 10,000 ppm
Floor drains sediments within building: Up to 64,600 ppm
LEGEND
Drywell
Floor Drain
Municipal Drywell
Sewer Line
Drain Line
Site Building
Site Area
Approximate Site Boundary
Parcel Boundary
Excavation Areas
Excavate 1 foot below current site grade
Excavate 2 feet below current site grade
Excavate to approximate maximum depth shown
NOTES:
1) FD = Floor Drain.
2) DW = Drywell.
3) All site features and locations are approximate.
4) The original figure was produced in color. Significant information will be lost if copied in black and white.
SOURCES:
1) WA Ecology, 2017h.
2) Spokane County, Washington, 2017.
3) GeoEngineers, Inc., 2009.
5) WA Ecology, 2004.
4) ESRI, 2019a,b.
0 15 30 Feet
GRADIENT
City Parcel Remediation Areas
Spokane, Washington
FIGURE 12
Date: 11/13/2019



N
E Gordon Ave
E Gordon Ave
E Glass Ave
E Bridgeport Ave
E Bridgeport Ave
E Liberty Ave
E Liberty Ave
N Cook St
N Stone St
N Regal St
N Lacey St
Wall Property
Carbon Property
Spokane Metals Company
Spokane Junkyard
Site Location
Cochran Basin Sampling Location
Cochran Basin Discharge
Spokane River
Spokane
0 0.6 1.2 Miles
Sources of PCBs
Scrap metal items purchased from:
Kaiser Aluminum
Washington Water Power
Used transformers purchased from:
Inland Power and Light
Coulee Dam
Bonneville Power Administration
Oil from used transformers:
Drained directly into the ground during removal of copper coils
Oil may have been sold to local farmers for use in road maintenance
LEGEND
Municipal Drywell
Sewer Line
Approximate Extent of PCB Presence
1988 Excavation Area
1989 Excavation Area
Area Excavated During Remediation
Approximate Site Boundary
Property Boundary
NOTES:
1) All site features and locations are approximate.
2) The original figure was produced in color. Significant information will be lost if copied in black and white.
SOURCES:
1) Spokane County, Washington, 2017.
2) US EPA Region X, 2011.
3) Alta Geosciences, Inc., 1997.
4) E&E, 1991.
5) E&E, 1988.
6) USGS, 1980.
7) ESRI, 2019a,b.
0 90 180 Feet
GRADIENT
Spokane Junkyard Superfund Site
Spokane, Washington
FIGURE 13
Date: 11/12/2019


STEVENS COUNTY
SPOKANE COUNTY
LINCOLN COUNTY
BONNER COUNTY
KOOTENAI COUNTY
IDAHO
WASHINGTON
Spokane River Arm
Ford State Fish Hatchery
Spokane Tribal Fish Hatchery
Little Falls Dam
Long Lake Dam
Long Lake
Spokane River
RRA 7 Davenport
RRA 3 Dartford
Nine Mile Dam
Nine Mile Reservoir
Spokane State Fish Hatchery
City of Deer Park
Eloika Lake
Newman Lake
Twin Lakes
Lake Hayden
Hayden Area WWTP
Post Falls WWTP
Post Falls Dam
Coeur d'Alene Advanced WWTP
Coeur d'Alene Lake
RRA 6 Trentwood
Spokane Industrial Park
BNSF Freya Site
Liberty Lake WWTP
Liberty Lake
RRA Reardon
City of Reardan
NIKE 87 Spokane (Control)
NIKE 87 Spokane (Launch)
City of Deep Creek
Spokane International Airport
Airway Heights WWTP
Fairchild Air Force Base
NIKE 45 Medical Lake (Launch)
Medical Lake WWTP
Upper Falls Dam
Monroe Street Dam
Upriver Dam
Mica Peak
Freeman School District WWTP
Rockford WWTP
Spangle STP
BNSF Hillyard Lead Soil Site
Riverside Park Advanced WWTP
Spokane Metals
Spokane Junkyard and Associated Properties
Inland Empire Paper
Kaiser Trentwood Facility
BNSF Parkwater Railyard
GE, Service Shop
Former Pentzer WWTP
Spokane County Regional Water Reclamation Facility
Inland Metals
Schade Brewery
Barrier Trust Property
Spokane Transformer/ City Parcel
LEGEND
Dam
PCB Upland Site
NPDES Permitted Discharge
PCB 11 in Surface Water Sample
Not Detected
Detected
Spokane River Watershed Boundary
Spokane City Boundary
Other City Boundary
County Boundary
State Boundary
NOTES:
1) All site features and locations are approximate.
2) The original figure was produced in color. Significant information will be lost if copied in black and white.
SOURCES:
1) US EPA, 2017a,b.
2) US Census Bureau, 2015.
3) US Census Bureau, 2016a,b.
4) WA Ecology, 2017a,b,f,g.
5) US EPA Region X, 2014.
6) WA Ecology, 2019a.
0 2.5 5 Miles
0 1 2 Miles
GRADIENT
PCB 11
Detected in Surface Water
Spokane, Washington
FIGURE 14
Date: 11/13/2019

Attachment 1

***Curriculum Vitae* and Testimony Experience of Kurt Herman, M.Eng., P.G.**

GRADIENT

Kurt Herman, M.Eng., P.G.
Principal
kherman@gradientcorp.com

Areas of Expertise

Contaminant fate and transport, environmental cost analysis, hydrogeology, site characterization and remediation strategy, historical waste practices, non-aqueous phase liquids (NAPLs), polycyclic aromatic hydrocarbons (PAHs), manufactured gas plants (MGPs).

Education

M.Eng., Civil and Environmental Engineering, Massachusetts Institute of Technology, 2002

Graduate Coursework in Subsurface Hydrology, University of Arizona's Department of Hydrology and Water Resources, 2000-2001

B.A., Double Major in Economics and Geology, Miami University (Ohio), 1997

Professional Geologist No. 3288, Washington State

Registered Professional Geologist No. G2184, Oregon

OSHA 40-Hour Hazardous Waste Operations and Emergency Response (HAZWOPER) Certification; 8-Hour Refresher Certification

Professional Experience

2002 – Present GRADIENT, Cambridge, MA
Principal. Operations Manager (2017-2019). Editor of Gradient's *Trends* newsletter (2011-2019). Technical Manager (2014-2016). Environmental Sciences Group Manager (2009-2014). GIS Group Manager (2012-2014).

2000 – 2001 UNIVERSITY OF ARIZONA, Tucson, AZ
Research Assistant for National Institute for Environmental Health Sciences (NIEHS) Superfund Colloquium. Surface water modeling (stream-groundwater interaction) of an acid mine drainage-impacted Arizona creek.

1997 – 2000 SADAT ASSOCIATES, INC., Princeton, NJ
Environmental Scientist. Responsible for the investigation and remediation of a wide range of hazardous waste sites (*e.g.*, MGP, petroleum, chlorinated solvents, inorganics).

Professional Activities and Affiliations

- Sigma Xi – Scientific and Engineering Honorary, MIT Chapter.
- American Bar Association. Vice Chair for the Environmental Disclosure Committee.
- American Society for Civil Engineers.
- Society for Environmental Toxicology and Chemistry (SETAC).

5/13/2019

- Society for Environmental Toxicology and Chemistry (SETAC) Sediment Advisory Group (SEDAG).
- Editorial Board of *Remediation* Journal
- Peer Reviewer:
  - *Soil and Sediment Contamination: An International Journal*
  - *Environmental Forensics*
  - *International Journal of Environmental Analytical Chemistry*
  - *Remediation*
- Session Chair:
  - "NAPLs – Plume Characterization and Remediation Strategies," Battelle Seventh Annual Conference, Remediation of Chlorinated and Recalcitrant Compounds. 2010.
  - "Performance Based Environmental Management," Battelle Tenth Annual Conference, Remediation of Chlorinated and Recalcitrant Compounds. 2016.
- Guest Lecturer:
  - "NAPL Delineation and Mobility – Practical Considerations." MIT Course 1.34 (Waste Containment and Remediation Technology). 2013, 2014, 2015.
  - "Overview of PAH Forensics at a Superfund Site." MIT Civil and Environmental Engineering (Course 1) Master of Engineering Program. 2014.

Projects – *Site Characterization/Remediation; Contaminant Fate & Transport*

<u>Watershed PCB Fate and Transport</u>: Evaluated PCB sources, fate, and transport for a watershed. Litigation context.

<u>NAPL Fate and Transport</u>: Evaluated NAPL (tar, creosote, petroleum) fate and transport from potential sources (railyard, MGP, roofing plants, petroleum, tar refineries) in a previously industrialized area of Denver, Colorado.

<u>Landfill, KY</u>: Performed remedy alternative analysis for addressing TENORM waste in a landfill.

<u>Watershed PCB Fate and Transport</u>: Evaluated PCB sources, fate, and transport for a watershed. Litigation context.

<u>Commercial Facility, ND</u>: Developed and implemented indoor air sampling protocol to evaluate PCE/TCE source and develop mitigation strategy.

<u>Former Manufactured Gas Plant, ND</u>: Developed risk-based site characterization and remediation strategy for an MGP site in an urban residential/commercial area.

<u>Former Manufactured Gas Plants, CA</u>: Performed technical peer review of site characterization program.

<u>Trade Association</u>: Evaluated the feasibility of remediating MGP tar in fractured bedrock.

<u>Industrial Client, Portland, OR</u>: Registered Geologist for RI/FS at an industrial site in Oregon. Petroleum hydrocarbon (LNAPL).

<u>Superfund Site, Dover, DE</u>: Extensive multi-media (DNAPL, soil, groundwater, soil gas) investigation of PCE released in a downtown residential/commercial area.

Pharmaceutical Manufacturer, Argentina: Developed risk-based remediation strategy and conceptual design (dual-phase extraction) for soil and groundwater contamination (VOCs included acetone, toluene, and chlorinated solvents).

Superfund Site, Clifton, NJ: Multi-media chlorinated solvent (DNAPL) investigation. Seepage pit closure.

Box Maker, Clifton, NJ: Fuel oil UST closure. Site investigation (soil, groundwater) of gasoline UST release. Remediation of gasoline impacts by chemical oxidation/bioremediation.

Former Manufactured Gas Plant, Hoboken, NJ: Expedited remedial investigation (soil, groundwater) of MGP site in urban area.

Auto Body Shop, Central NJ: Planned and directed remediation (excavation and disposal) of chlorinated solvent-impacted soils. Implemented sampling protocol to confirm appropriateness of monitored natural attenuation as post-excavation groundwater remedy.

Alloy Metal Distributor, Secaucus, NJ: Site investigation of fuel oil impacts (soil, groundwater).

Industrial Client, NJ: Planned and directed multimedia (soil, groundwater, surface water, sediments, wetlands) investigation of an ammonia plume impacting a potable aquifer and discharging to surface water (lake and wetlands).

Sediment Study, NY/NJ: Planned and directed sediment core study to assess chemical and physical feasibility of reusing sediments dredged from the Arthur Kill as stabilized soil cap at a Brownfields site.

Brownfields Site, Woodbridge, NJ: Site investigation (soil, sediments, wetlands) for Brownfields redevelopment suitability determination at 290-acre historic fill and active rail facility site. Metals, pesticides, and herbicides.

Prosthetic Limb Manufacturer, Meadowlands, NJ: Site investigation (overburden and bedrock soil and groundwater) of VOCs.

Bulk Oil Storage Terminal, Staten Island, NY: Site investigation (soil, groundwater, LNAPL) of bulk oil storage terminal with extensive LNAPL (diesel, fuel oil, gasoline) contamination.

Warehousing and Distribution Facility, Jersey City, NJ: Site investigation (soil, groundwater, LNAPL) of No. 6 fuel oil release.

Rail Spur, Jersey City, NJ: Site investigation (soil, sediment, wetland) of rail spur/historical fill area. Herbicides, pesticides, and metals.

Fragrance Manufacturer, Edison, NJ: Remedial investigation (soil, sediment, groundwater) of historical waste disposal operable units, including buried drums, seepage pits, and solid waste disposal areas.

Landfill Investigation, Secaucus, NJ: Site characterization of former municipal landfill for potential Brownfields reuse.

Large Chemical Plant, Elizabeth, NJ: Reviewed potential environmental liabilities for prospective purchaser redeveloping 100+ year chemical plant into a cogeneration facility. Evaluated pile design considerations to avoid contamination drag-down.

Beneficial Reuse Determination, Brooklyn, NY: Beneficial reuse determination (regulatory, physical, and chemical evaluation) of soils from various Newtown Creek industries as stabilized soil cap.

Multiple Municipal, Commercial, and Industrial Facilities: Assessed potential environmental liabilities and evaluated baseline conditions at multiple properties pursuant to commercial real estate transactions (*e.g.*, ASTM Phase I).

Projects – *Environmental Cost Analysis*

Environmental Damage Analysis: Rebuttal expert on environmental damages for a site in New Jersey.

Remedial Design Cost Allocation: Sediment PAH forensics and remedial design cost allocation for an east coast water body.

Landfill NCP Consistency Evaluation: Rebuttal expert on the NCP consistency of work performed at a municipal solid waste landfill in Illinois.

Landfill Cost Allocation: Rebuttal expert on cost allocation for a PCB-impacted landfill site in Massachusetts.

Probabilistic Cost Analysis: Prepared environmental liability cost estimates for a portfolio of sites using probabilistic cost modeling tools, including stochastic (Monte Carlo) methods. Incorporated cash flow modeling. Estimates prepared for regulatory disclosure.

Brazilian Mine Acquisition: Developed cost estimates for contingent environmental liabilities associated with a clay mine in Brazil.

Sediment PAH Allocation: Sediment PAH forensics and allocation for an east coast water body

NCP Consistency and Cost Allocation: Rebuttal expert on NCP consistency and cost allocation for a tar-impacted site in New York City.

Confidential Client: Testifying expert to evaluate the appropriateness of response costs allegedly incurred at a waste oil recycling site in Indiana.

Confidential Client: Served on an independent review panel to evaluate environmental reserve estimation procedures.

Utility Company: Evaluated the need for and environmental liability costs associated with a US EPA-led time critical removal action for a former MGP site. Used probabilistic cost modeling techniques to develop a range of cost estimates for the proposed remedial actions in support of settlement negotiations.

NCP Consistency Evaluation: Evaluated the NCP consistency of response actions performed at a groundwater NPL site.

Confidential Client: Evaluated technical aspects of a cost allocation proposal and applied financial modeling incorporating uncertainty in support of settlement negotiations.

Utility Company: Performed third-party review/critique of remediation cost estimates developed for a sediment Superfund site. Used in support of settlement negotiations.

Superfund Site Cost Allocation: Developed multiple PRP cost allocation involving former MGP and wood treating operations. Performed forensic evaluation of PAH/NAPL contaminant releases to sediment, including a source mixing model used for source apportionment.

NCP Consistency Evaluation and Remedy Negotiation Support: Prepared comments on US EPA's proposed Superfund site remedy. Evaluated the basis for each major remedy element in the context of consistency with the NCP. Demonstrated that the proposed remedy did not comply with the NCP, whereas several remedial alternatives considered, but not selected, met the NCP requirements.

NRD Settlement Analysis: Evaluated the basis for a proposed NRD settlement offer at a Great Lakes Superfund site. Used benchmarking analysis techniques to quantitatively compare the proposed offer to NRD settlements at other sediment sites.

Superfund Site Cost Allocation: Provided technical support in evaluating cost allocation issues at an industrial site in Oregon. Analyzed information regarding the nature and extent of contamination within the site and assessed factors that could be evaluated to apportion costs among potentially responsible parties.

Projects – *Historical Operations and Waste Practices*

PRP Search (Chlorinated Solvent Sources): Multi-faceted research effort to identify potential sources of chlorinated solvents in Long Island, New York.

PRP Search (Hydrocarbon Sources): Multi-faceted research effort to identify potential hydrocarbon sources, including tar and petroleum, in a previously industrialized area of Denver, Colorado.

PRP Search (PAH Sources): Multi-faceted research effort to identify potential PAH sources in a commercial/industrial area of Fargo, North Dakota.

Northeast Utility Company: Testified as a 30(b)(6) witness regarding historical (c. 1900-1975) MGP and power plant operations, including waste handling, byproduct disposition, and decommissioning.

> 30 MGPs, Multiple Projects, Nationwide: Researched and reconstructed historical operations and release history (1850-1960) at multiple MGPs for insurance cost recovery claims.

Flare Maker: Evaluated the standard of care for perchlorate handling from c. 1956-1985 in the context of regulations, waste handling practices, and analytical capabilities during that time frame.

Glassmaking Plant: Evaluated potential releases of arsenic during historic glassmaking operations *via* a mass balance approach.

Insurance Recovery for 260-acre Industrial Complex, MA: Researched historical operations and waste practices for insurance cost recovery at a 260-acre industrial complex including a former coke plant, tar refinery, and blast furnace.

Publications/Presentations

Tuit, C; Herman, K. [Gradient]. 2019. "Diagenetic Magnification of Persistent Organic Pollutants from Combined Sewage Overflow Sources." Presented at Battelle Tenth International Conference on Remediation and Management of Contaminated Sediments Conference, New Orleans, LA, February 13.

Herman, K; Tuit, C; Sharma, M; Kneeland, J. [Gradient]. 2019. "Quantitative Methods for Allocating Multiple Contaminant Types in Sediments." Presented at Battelle Tenth International Conference on Remediation and Management of Contaminated Sediments Conference, New Orleans, LA, February 14.

Herman, K. 2019. "Editorial: Cost considerations at sediment sites." *Gradient Trends - Risk Science & Application* 74(Winter):6.

Boroumand, A; Greenberg, G; Herman, K; Lewis, A. 2017. "Incorporating green and sustainable remediation analysis in coal combustion residuals (CCR) surface impoundment closure decision making." *Remediation* 27(4):29-38. doi: 10.1002/rem.21527.

Boroumand, A; Herman, K. 2017. "Green and Sustainable Remediation Analysis: Coal Ash Surface Impoundment Closure." Presented at Battelle's Fourth International Symposium on Bioremediation and Sustainable Environmental Technologies, Miami, FL, May 24.

Boroumand, A; Herman, K; Lewis, A. 2017. "Evaluating Worker and Community Safety in Coal Ash Surface Impoundment Closure Decision-Making." Presented at the 2017 World of Coal Ash Conference (WOCA), Lexington, Kentucky, May 8-11, 23p.

Herman, K; Lewis, A; Bittner, AB; Dubé, E; Long, C; Hensel, B; Ladwig, K. 2016. "Framework for Evaluating Coal Ash Surface Impoundment Closure Options." Presented at the Battelle Tenth Annual Conference, Remediation of Chlorinated and Recalcitrant Compounds, May 26.

Flewelling, S; Boroumand, A; Herman, K. 2016. "A Conceptual Framework for Feasibility of Remediating MGP Tar in Fractured Bedrock." Presented at the Battelle Tenth Annual Conference, Remediation of Chlorinated and Recalcitrant Compounds, May 23.

Principal Investigator for Electric Power Research Institute (EPRI) Report 3002007543. 2016. "Relative Impact Framework for Evaluating Coal Combustion Residual Surface Impoundment Closure Options." May.

Principal Investigator for Electric Power Research Institute (EPRI) Report 3002007542. 2016. "Qualitative Application of the Relative Impact Framework to Ten Tennessee Valley Authority Surface Impoundments." April.

Herman, K; Flewelling, SA; Bittner, AB; Tymchak, MP; Swamy, M. 2015. "Alternate Endpoints for Remediating NAPL-Impacted Sites." 19p. Presented at EPRI/AWMA Env-Vision Conference, Crystal City, VA, May 14.

Lewis, A; Bittner, AB; Herman, K; Dubé, E; Long, C; Hensel, B; Ladwig, K. 2015. "Framework for Evaluating Relative Impacts for Surface Impoundment Closure Options." Presented at the 2015 World of Coal Ash Conference, Nashville, TN, May 8.

Bittner, AB. Lewis, A; Herman, K; Dubé, E; Long, CM; Kondziolka, K, Hensel, B; Ladwig, K. 2015 "Groundwater Assessment Framework to Evaluate Relative Impacts of Surface Impoundment Closure Options." Presented at the 2015 World of Coal Ash Conference, Nashville, TN, May 7.

Lemay, JC; Mayfield, DB; Herman, K; Verslycke, T. 2014. "PAH-Contaminated Sediments: Remediation Challenges." Presented at the Society of Environmental Toxicology and Chemistry (SETAC) North America 35th Annual Meeting, Vancouver, BC, November 9-13.

Principal Investigator for Electric Power Research Institute (EPRI) Report 3002004104. 2014. "Feasibility of Remediating Manufactured Gas Plant Tar in Bedrock (Technical Update)." September.

Herman, K. 2014. "Actuarial risk analysis to promote National Contingency Plan (NCP)-consistent remediation." *Remediation Journal* Summer.

Herman, K. 2013. "Bridging the GAAP: Turning to environmental accounting guidance to interpret what constitutes a CERCLA response cost." American Bar Association Section of Environment, Energy, and Resources. *Environmental Disclosure Committee Newsletter* July.

Herman, K. 2013. "Do More Harm than Good? Actuarial Risk Analysis to Support Informed Remedy Selection." Presented at the Second International Symposium on Bioremediation and Sustainable Remediation Technologies, Jacksonville, FL, June 12.

Herman, K; Wannamaker, EJ; Jegadeesan, GB. 2012. "Sediment PAH allocation using parent PAH proportions and a least root mean squares mixing model." *Environmental Forensics* 13:3.

Herman, K. 2012. "Environmental Liability Cost Estimation (ELCE) at MGP Sites." Presented to the MGP Consortium, Savannah, GA, January 25.

Herman, K. 2011. "Chemical Profile: Molybdenum." Presented at EPRI P40 Summer Meeting, Asheville, NC, July 12.

Principal Investigator for Electric Power Research Institute (EPRI) Report 2011815. 2011. "Chemical Constituents in Coal Combustion Products: Molybdenum."

Herman, K. 2011. "Remedy sustainability: Is the cure worse than the disease?" *Gradient Trends – Risk Science & Application* 50:6.

Herman, K; Bittner, AB. 2010. "How Much Tar is in the Mud? – Reducing Uncertainty in Characterizing the Distribution and Mass of DNAPL In Sediments." Presented at the EPRI MGP 2010 Symposium, San Antonio, TX, January 28.

Wannamaker, EJ; Herman, K; Butler, EL; Petito Boyce, C; Jakubiak, J. 2010. "Subsurface LNAPL Behavior in a Tidal Zone: A Case Study." Presented at the Seventh International Battelle Conference, Remediation of Chlorinated and Recalcitrant Compounds, Monterey, CA, May 27.

Herman, K. 2009. "Sediment DNAPL challenges." *Gradient Trends – Risk Science & Application* 45:5.

Herman, K; Bittner, A. 2008. "Reducing Uncertainty in DNAPL Characterization." Presented at the 24th Annual International Conference on Soils, Sediments, and Water, Amherst, MA, October 23.

Wannamaker, EJ; Bittner, AB; Butler, EL; Herman, K; Jakubiak, J; Petito Boyce, C. 2009. "Mobility of Subsurface LNAPL in a Tidal Zone: A Case Study." Presented at the 2009 Geological Society of America Annual Meeting, Portland, OR, October 21.

Herman, K. 2008. "A Standardized Method to Interpret Field Observations of MGP NAPL." Presented at the 18th Annual AEHS Conference, March 11.

Herman, K. 2007. "Who pays for cleanup costs?" *Gradient Trends – Risk Science & Application* 38:1.

Langseth, DE; Herman, K. 2006. "Liability estimation frameworks" *Gradient Trends – Risk Science & Application* 36:3.

Herman, K. 2002. "Basin-scale Modeling of Nutrient Impacts in the Eel River Watershed, Plymouth, Massachusetts [Thesis]." Submitted to Massachusetts Institute of Technology, Dept. of Civil and Environmental Engineering.

Herman, K. 2000. "Metal Removal in the Hyporheic Zone in a Mining Contaminated Stream in Arizona." Presented to NIEHS Superfund Colloquium, Tucson, AZ, December.

KURT HERMAN
Testimony Experience

Mr. Herman has provided testimony regarding environmental response actions, contaminant fate and transport, environmental response costs, and historical industrial operations.

1. Northern States Power Company v. Aegis Insurance Services, Inc., *et al*. (Case No. 3:15-cv-00106, US District Court, District of North Dakota). On behalf of plaintiff in an insurance cost recovery lawsuit, evaluated the nature and timing of historical releases associated with a former manufactured gas plant (MGP), as well as whether the response actions performed were reasonable, necessary, and cost-effective. Provided Expert and Rebuttal Reports and testified in deposition (2019).

2. John DaRosa *et al*. v. City of New Bedford, v. Monsanto Company *et al*. (Commonwealth of Massachusetts Superior Court Department, Civil Action No. BRCV2008-01429A). On behalf of third party Defendants for a cost recovery lawsuit, developed a cost allocation for PCB-impacted landfill site characterization and remediation costs. Provided an Expert Report (2016).

3. Allied Waste Transportation, Inc. *versus* Bellemead Development Corp., John Sexton Sand & Gravel Corp., Todd Sexton Daniels, and Arthur A. Daniels. (Case No. 13-CV-1029, US District Court, Northern District of Illinois). On behalf of Defendants for a CERCLA cost recovery lawsuit, evaluated whether landfill closure activities were performed consistent with the requirements of the National Contingency Plan (NCP). Provided an Expert Report and testified in deposition (2015).

4. Northern States Power Company *versus* The City of Ashland, Wisconsin, *et al*. (Case No. 12-CV-602, US District Court, Western District of Wisconsin). On behalf of Plaintiff in a CERCLA cost recovery lawsuit, analyzed contribution of historical manufactured gas plant (MGP) and railroad operations to site contamination (PAHs and NAPLs). Performed contaminant fate and transport and mass loading analyses to evaluate PRP contributions to site contamination. Issued several Expert and Rebuttal Reports (2014) , and testified in deposition (2014) and trial (2015).

5. BorgWarner Inc., and Kuhlman Corporation *versus* Kuhlman Electric Corporation (KEC) and KEC Acquisition Corporation (KAC) (Case No. 2010 L 8893, Circuit Court of Cook County, Illinois 1st Judicial District). On behalf of Defendants in a business transaction lawsuit, provided deposition testimony and an expert declaration (2014) regarding environmental response actions that were performed to address PCBs at a former transformer manufacturing facility.

6. Queens West Development Corporation, AvalonBay Communities, Inc., Avalon Riverview North, LLC, f/k/a Avalon Riverview III, LLC *versus* Honeywell International, Inc. (Case No. 3:10-cv-4876, US District Court, District of New Jersey). On behalf of plaintiffs for a CERCLA cost recovery lawsuit involving a DNAPL and PAH-impacted Site in New York City, performed NCP consistency evaluation and response cost analysis. Issued an expert rebuttal report (2013). Case settled prior to deposition.

7. American International Specialty Lines Insurance Co. *versus* Bee Environmental Management, Inc. (Civil Action No. 49D07-0907-CT-031570, Superior Court, Indiana Superior Court, Marion County). In a cost recovery lawsuit on behalf of defendant evaluated whether costs allegedly incurred for decontaminating tanks containing PCB-contaminated oil were reasonable and necessary. Testified in deposition (2013). Case settled prior to trial.

8. Donna M. Avila, et al. *versus* Willits Environmental Remediation Trust, et al. (Case No. C-99-3941-SI, US District Court, Northern District of California). On behalf of Defendants, performed geospatial analyses to evaluate alleged plaintiff exposures to chromium and TCE at a former chrome-plating facility in California. Issued an Expert Declaration (2012).

9. OneBeacon America Insurance Company *versus* Narragansett Electric Company (Civil Action No. 05-3086-BLS-I, Superior Court, Massachusetts Superior Court, Suffolk County). On behalf of Defendant in an insurance cost recovery lawsuit, testified as a 30(b)6 witness regarding historical manufactured gas plant and electrical generation plant operations and contaminant releases, including PAHs, DNAPL, and PCBs. Multiple days of deposition testimony (2009; 2010).

Attachment 2

Summary of PCB Studies and Data in the Spokane River Watershed

A2.1 WA Ecology Studies

In response to detections of polychlorinated biphenyls (PCBs) in fish tissue in the Spokane River, the Washington State Department of Ecology (WA Ecology) initiated certain PCB sampling efforts and analyses (PCB Source Assessment; WA Ecology, 2011a). A total maximum daily load (TMDL) was proposed in 2006 but was not implemented due to the need for more accurate data on local fish consumption (King County, Washington, 2016). In recent years, multiple studies have assembled PCB concentration measurements within the Spokane River watershed – from the river itself, from tributaries, and from effluent pipes – in an attempt to understand the total PCB load[1] within the river and the potential major PCB sources within the watershed. WA Ecology assembled measurements of PCBs in sediments, fish, water, and suspended sediments in the Spokane River, as well as in effluent wastewater from both industrial facilities and municipalities, and stormwater from certain City of Spokane conveyances from the period between 2003 and 2007.

The WA Ecology (2011a) study also documented the historical PCB sampling efforts in the Spokane River watershed, including studies led by WA Ecology and others (see Chart A2.1). While samples in fish tissue were collected starting in 1980, WA Ecology did not perform surface water sampling in the Spokane River until 1994 in a synoptic survey of fish tissue, sediment, surface water, and effluent concentration, and at that time only two surface water samples were collected from the 112-mile-long Spokane River (WA Ecology, 1995). Prior to the 2011 PCB Source Assessment, WA Ecology also performed two limited PCB point source surveys in the Spokane River to attempt to identify potential major sources of PCB loading (WA Ecology, 2001, 2002). However, the 2001 WA Ecology study (WA Ecology, 2001) suffered from reported laboratory contamination issues, causing the majority of the results to be rejected.

[1] The total PCB load within the river (mass/day) is a product of the PCB concentration in the water and the volumetric flow rate of the river.

1980s

- **Basic Water Monitoring Program Fish Tissue and Sediment Sampling for 1984** 1980-1983
- **Basic Water Monitoring Program Fish Tissue and Sediment Sampling for 1989** 1989

1990s

- **Survey of Chemical Contaminants in Ten Washington Lakes** 1992
- **Results from 1993 Screening Survey on PCBs and Metals in the Spokane River** 1993
- **Washington State Pesticide Monitoring Program – 1993 Fish Tissue Sampling Report** 1993
- **Department of Ecology 1993-94 Investigation of PCBs in the Spokane River** 1994
- **Final Report, Supplemental 1994 Spokane River PCB Investigations Kaiser Aluminum and Chemical Corporation** 1994
- **Particulate Matter and PCBs in the Spokane River** 1994
- **Spokane River PCB Source Monitoring Follow-up Study, November and December 1995** 1995
- **1996 Results on PCBs in Upper Spokane River Fish** 1996
- **Results from Analyzing PCBs in 1999 Spokane River Fish and Crayfish Samples** 1999

2000s

- **Chemical Analysis and Toxicity Testing of Spokane River Sediments Collected in October 2000** 2000
- **Spokane River PCB and Source Survey, August 2000** 2000
- **Spokane Area Point Source PCB Survey, May 2001** 2001
- **Analysis of Fish Tissue from Long Lake (Spokane River) for PCBs and Selected Metals** 2001
- **Sediment Characterization of Sediment in the Spokane River Upstream of the Upriver Dam** 2001
- **Report of Wastewater and Sludge Sampling at Inland Empire Paper Company** 2002
- **Report of Sampling and Analysis for PCBs in Fish Tissue from Lake Coeur d'Alene** 2002
- **Water Compliance Inspection Report for Kaiser Aluminum and Chemical Corporation – Trentwood Works** 2002-2003
- **Focused Remedial Investigation Report – Upriver Dam PCB Sediment Site** 2003
- **Unpublished Report of PCB analyses from Axys Analytical Service** 2004-2005
- **PCBs, PBDEs, and Selected Metals in Spokane River Fish, 2005** 2005
- **Washington State Toxics Monitoring Program: Toxic Contaminants in Fish Tissue and Surface Water in Freshwater Environments, 2003** 2005
- **Persistent Organic Pollutants in Feed and Rainbow Trout from Selected Trout Hatcheries** 2006
- **Spokane River PCB Source Assessment** 2003-2007
- **Spokane River PCB TMDL Stormwater Loading Analysis Final Technical Report** 2007

2010s

- **Spokane River Urban Water Source Investigation and Data Progress Report** 2009-2011
- **Spokane River Fish Tissue Monitoring** 2012
- **Spokane River Toxics Reduction Strategy** 2012
- **Spokane River Toxics Monitoring** 2012-2013
- **PCBs in General Consumer Products** 2014
- **PCB Chemical Action Plan** 2015
- **PCBs in Consumer Products** 2016

Chart A2.1 WA Ecology Activities in the Spokane River Watershed. PBDE = Polybrominated Diphenyl Ether; PCB = Polychlorinated Biphenyl; TMDL = Total Maximum Daily Load; WA Ecology = Washington State Department of Ecology. Assembled from WA Ecology (2011a, 2012a, 2014a,b, 2016), WA Ecology and WADOH (2015), Donovan (2013, 2014, 2015).

A2.2 Spokane River Regional Toxics Task Force Studies

Following the WA Ecology PCB Source Assessment and additional WA Ecology studies, the Spokane River Regional Toxics Task Force (Task Force) was established in 2012 (WA Ecology, 2012b). The Task Force includes representatives from the City of Spokane, Washington State, citizen groups, and industrial groups. All National Pollutant Discharge Elimination System (NPDES)-permitted dischargers in the Spokane River are part of the Task Force per the revised 2011 NPDES permit's conditions (WA Ecology, 2011b).

The Task Force assembled a database of PCB sampling in the Spokane River from WA Ecology studies, upland site investigations, and publicly available databases, as well as from multiple Task Force sampling events, and issued its plan to reduce PCBs in the Spokane River in 2016 (LimnoTech, 2016a). The Task Force performed additional sampling after the data used in the Comprehensive Plan were finalized in 2013. In 2014 and 2015, the Task Force performed low-flow synoptic[2] surveys in the Spokane River water as well as in discharge pipes (LimnoTech, 2015, 2016b). These studies were used to identify potential unmonitored dry-weather PCB sources, such as groundwater discharge or unmonitored effluent sources. The Task Force performed additional monthly PCB sampling in 2016 in order to better understand seasonal variability in the Spokane River (LimnoTech, 2017).

The Task Force also conducts studies that address PCB products used in the Spokane River watershed (Chart A2.2). In 2015, the Task Force performed a study of the presence of PCBs in hydroseed – a slurry of grass seed and mulch used to replant bare ground – with the goal of providing information to hydroseed manufacturers to help them reduce PCBs in their products (SRRTTF, 2015).

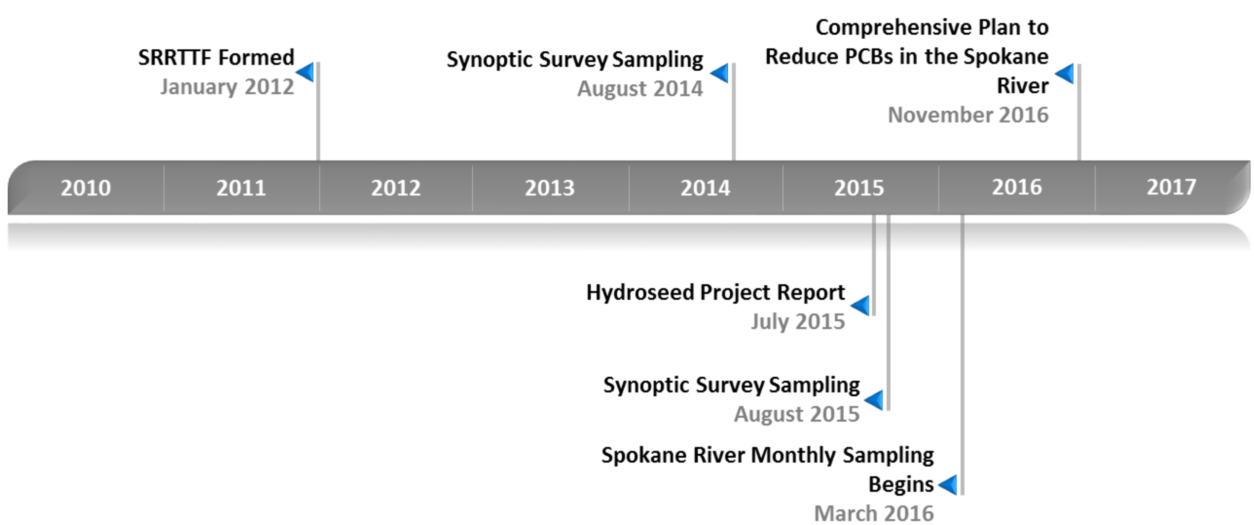


Chart A2.2 Spokane River Regional Toxics Task Force PCB Activities. PCB = Polychlorinated Biphenyl; SRRTTF = Spokane River Regional Toxics Task Force.

[2] The term "synoptic" refers to simultaneous (or near-simultaneous) sampling for concentration and river flow, which allows for a point-in-time mass loading estimate.

A2.3 Summary of PCB Data in the Spokane Watershed

I assembled a comprehensive database of PCB data collected in the Spokane River watershed. These data come from multiple studies over the past several decades and include data from the following media: surface water, groundwater, soil, sediment, stormwater, stormwater sediment, wastewater discharges, combined sewer overflow (CSO) discharges, sludge/biosolids, landfill leachate, fish tissue, and municipal and consumer products. These data were checked for quality, accuracy, and consistency and were compiled into the database with a standardized set of units so my analyses could draw from a uniform database.

Total PCBs are calculated by the summation of the 209 congeners reported in the underlying dataset. Non-detects are treated as zero in the summation. If all the congeners in the sum are not detected, then the single highest MDL among the congeners measured is used for the total PCBs congener value. If the congener results are not provided, but Aroclor concentrations are provided, then total PCBs is calculated by the summation of Aroclors (1016, 1221, 1232, 1242, 1248, 1254, 1260, 1262, and 1268). If all Aroclors in the sum are not detected, then the single highest MDL among the Aroclors measured for the sample is used to represent the total PCBs Aroclors value.

I did not perform any additional blank correction beyond what is reported in the underlying studies. Blank flags were preserved and blank-corrected data was used when it was provided in the underlying studies.

Table A2.1 summarizes the PCB data sources that were compiled into the database, including the number of samples from each type of environmental media, the detection frequency, the availability of PCB congener data, the date range of available samples, and the PCB concentration range in those samples.

References

Donovan, J. [Spokane, Washington, RPWRF Laboratory]. 2013. "2012 Annual Summary of RPWRF Toxics Monitoring." 80p., August 20.

Donovan, J. [Spokane, Washington, RPWRF Laboratory]. 2014. "2013 Annual Summary of RPWRF Toxics Monitoring." 89p., April 9.

Donovan, J. [Spokane, Washington, RPWRF Laboratory]. 2015. "2014 Annual Summary of RPWRF Toxics Monitoring." 71p., September 9.

King County, Washington. 2016. "A Review of Select PCB Source Tracing Programs." Dept. of Natural Resources and Park, Water and Land Resources Division. Report to Washington State Dept. of Ecology (WA Ecology). 170p., July.

LimnoTech. 2015. "Spokane River Regional Toxics Task Force Phase 2 Technical Activities Report: Identification of Potential Unmonitored Dry Weather Sources of PCBs to the Spokane River." Report to Spokane River Regional Toxics Task Force (SRRTTF). 62p., August 12.

LimnoTech. 2016a. "2016 Comprehensive Plan to Reduce Polychlorinated Biphenyls (PCBs) in the Spokane River." Report to Spokane River Regional Toxics Task Force. 125p., November 29.

LimnoTech. 2016b. "Draft: Spokane River Regional Toxics Task Force 2015 Technical Activities Report: Continued Identification of Potential Unmonitored Dry Weather Sources of PCBs to the Spokane River." Report to Spokane River Regional Toxics Task Force (SRRTTF). 68p., June 30.

LimnoTech. 2017. "Spokane River Regional Toxics Task Force 2016 Monthly Monitoring Report (Draft)." Report to Spokane River Regional Toxics Task Force (SRRTTF). 42p., May 4.

Spokane River Regional Toxics Task Force (SRRTTF). 2015. "Hydroseed Pilot Project Summary Report." 54p., July 31.

Washington State Dept. of Ecology (WA Ecology). 1995. "Department of Ecology 1993-94 Investigation of PCBs in the Spokane River." Publication No. 95-310. 88p., February.

Washington State Dept. of Ecology (WA Ecology). 2001. "Spokane River PCB and Source Survey, August 2000." Publication No. 01-03-016. 35p., April.

Washington State Dept. of Ecology (WA Ecology). 2002. "Spokane Area Point Source PCB Survey, May 2001." Publication No. 02-03-009. 94p., March.

Washington State Dept. of Ecology (WA Ecology). 2011a. "Spokane River PCB Source Assessment, 2003-2007." Publication No. 11-03-013, 156p., April.

Washington State Dept. of Ecology (WA Ecology). 2011b. "Fact Sheet for NPDES Permit WA-0093317, Spokane County Regional Water Reclamation Facility (SCRWRF) (Final)." 65p., November 28.

Washington State Dept. of Ecology (WA Ecology). 2012a. "Spokane River Toxics Reduction Strategy (Revised)." Publication No. 11-10-038. 33p., August.

Washington State Dept. of Ecology (WA Ecology). 2012b. "Spokane River Water Quality Improvement Projects: Spokane River PCBs Project." December.

Washington State Dept. of Ecology (WA Ecology). 2014a. "Freshwater Fish Contaminant Monitoring Program: 2012 Results." Environmental Assessment Program. Publication No. 14-03-020. 29p., May.

Washington State Dept. of Ecology (WA Ecology). 2014b. "Polychlorinated Biphenyls (PCBs) in General Consumer Products." Publication No. 14-04-035. 64p., June.

Washington State Dept. of Ecology (WA Ecology). 2016. "Polychlorinated Biphenyls in Consumer Products." Publication No. 16-04-014. 61p., November.

Washington State Dept. of Ecology (WA Ecology); Washington State Department of Health (WADOH). 2015. "PCB Chemical Action Plan." Publication No. 15-07-002. 223p., February.

Table

Table A2.1 Summary of PCB Data in the Spokane River Watershed

Author	Study Name	Media	Locations	Sampled	Detected	Detection Frequency	Earliest Sample Date	Latest Sample Date	Minimum Concentration	Average Concentration	Maximum Concentration	Units
WA Ecology	1203081 SRUW AXYS EDD MEL Amended	Stormwater	2	2	2	100%	3/26/2012	3/26/2012	0.077	0.090	0.102	µg/L
WA Ecology	1206085&1207107soil SRUW AXYS_40934PCB_MEL Amended	Soil	1	1	1	100%	6/27/2012	6/27/2012	12913.620	12913.620	12913.620	µg/kg
WA Ecology	EDD 1004061 & 1004071 Spokane Source Testing Part VIII DxF and PCB	CSO	1	1	1	100%	4/22/2010	4/22/2010	0.039	0.039	0.039	µg/L
WA Ecology	EDD 1004061 & 1004071 Spokane Source Testing Part VIII DxF and PCB	Stormwater	1	1	1	100%	4/29/2010	4/29/2010	0.061	0.061	0.061	µg/L
WA Ecology	EDD PCB Spokane River Source Tracing 1009069	Stormwater	2	2	2	100%	9/9/2010	9/9/2010	0.256	0.270	0.285	µg/L
WA Ecology	EDD PCB water 1107076 7086_revision 10-30-2012_all	CSO	1	1	1	100%	7/13/2011	7/13/2011	0.006	0.006	0.006	µg/L
WA Ecology	EDD PCB water 1107076 7086_revision 10-30-2012_all	Stormwater	1	1	1	100%	7/13/2011	7/13/2011	0.079	0.079	0.079	µg/L
WA Ecology	EDD Spokane R Source Tracing Part IV_PCB	Stormwater	2	2	2	100%	10/2/2009	10/2/2009	0.058	0.090	0.121	µg/L
WA Ecology	EDD Spokane R Source Tracing Part V 0910065 - PCB	Stormwater	4	4	4	100%	10/14/2009	10/14/2009	0.012	0.016	0.025	µg/L
WA Ecology	EDD Spokane R Source Tracing Part VI_0910084_PCB	CSO	2	2	2	100%	10/23/2009	10/23/2009	0.006	0.009	0.012	µg/L
WA Ecology	EDD Spokane R Source Tracing Part VI_0910084_PCB	Stormwater	4	8	8	100%	10/23/2009	10/26/2009	0.005	0.012	0.031	µg/L
WA Ecology	EDD SRUW 1103073 PCB_MEL Amended	Stormwater	2	2	2	100%	3/29/2011	3/29/2011	0.002	0.045	0.089	µg/L
WA Ecology	EDD SRUW 1104074 5057 5066 PCB	Stormwater	5	5	5	100%	4/21/2011	5/16/2011	0.000	0.173	0.745	µg/L
WA Ecology	EDD SRUW 1201050 PCB 27Sep12, Revised by Dave Hope_MEL amended	Other Water	1	1	1	100%	1/30/2012	1/30/2012	0.000	0.000	0.000	µg/L
WA Ecology	Spokane River Urban Waters Source Trace Study	Stormwater Sediment	2	2	2	100%	6/25/2009	6/25/2009	5.560	492.615	979.670	µg/kg
WA Ecology	Spokane River PCBs, 1993-1994	Fish	6	64	57	89%	7/7/1993	8/8/1994	6.000	347.200	2775.000	µg/kg
WA Ecology	Spokane River PCBs, 1993-1994	Sediment	5	17	15	88%	7/1/1993	8/1/1994	3.600	442.353	3000.000	µg/kg
WA Ecology	PCBs in Spokane River Fish in 1996	Fish	4	20	20	100%	8/13/1996	8/14/1996	38.400	333.275	1870.000	µg/kg
WA Ecology	Spokane River Biological Effects	Sediment	7	7	5	71%	10/23/2000	10/25/2000	2.000	571.140	1431.000	µg/kg
WA Ecology	1999 Spokane River Fish and Crayfish PCBs and Metals	Fish	5	69	67	97%	7/27/1999	10/14/1999	5.900	273.320	2170.000	µg/kg
WA Ecology	Background Assessment for Chemical Contaminants in Northeastern Washington Area Lakes	Sediment	2	4	0	0%	9/15/2009	10/2/2009				µg/kg
Exponent for DCO Management, LLC	Heglar Kronquist Landfill RI/FS, Mead, WA	Groundwater	2	3	0	0%	5/17/2010	1/25/2011				µg/L
Exponent for DCO Management, LLC	Heglar Kronquist Landfill RI/FS, Mead, WA	Other	1	1	1	100%	5/19/2010	5/19/2010	14.000	14.000	14.000	µg/kg
ERM Prepared for BNSF	BNSF Railway Black Tank Property - Remedial Investigation/Feasibility Study	Soil	10	12	12	100%	10/14/2013	10/29/2013	308.700	1924.883	6966.000	µg/kg
ERM Prepared for BNSF	BNSF Railway Black Tank Property - Remedial Investigation/Feasibility Study	Water	11	15	15	100%	12/3/2013	4/12/2016	0.246	46.410	278.100	µg/L
WA Ecology	Spokane River Toxics Preliminary Monitoring 2012 Through 2013 - In Support of the Long-term Toxics Monitoring Strategy	Sediment	2	4	4	100%	10/9/2012	2/1/2013	17.443	24.858	28.751	µg/kg
WA Ecology	Spokane River Toxics Preliminary Monitoring 2012 Through 2013 - In Support of the Long-term Toxics Monitoring Strategy	Surface Water	5	10	9	90%	10/24/2012	5/23/2013	0.000	0.000	0.000	µg/L
WA Ecology	Lake Spokane PCBs in Carp	Fish	1	15	15	100%	9/28/2014	9/29/2014	227.000	613.846	1350.720	µg/kg
WA Ecology	Spokane River PCBs and Other Toxics: Long-term Monitoring at the Spokane Tribal Boundary	Sediment	1	5	5	100%	4/29/2015	1/26/2016	8.150	14.466	29.337	µg/kg
WA Ecology	Spokane River PCBs and Other Toxics: Long-term Monitoring at the Spokane Tribal Boundary	Water	1	2	2	100%	1/26/2016	1/26/2016	0.000	0.000	0.000	µg/L
WA Ecology	1989 BWMP Fish Tissue and Sediment	Sediment	1	1	0	0%	1/18/1990	1/18/1990				µg/kg
Parsons for WA Ecology, US EPA Region X	Spokane River PCB TMDL Stormwater Analysis	Stormwater	14	46	44	96%	5/2/2007	6/5/2007	0.000	0.023	0.280	µg/L
Landau Associates	Deadman Creek - City of Mead, Spokane County - Sediment Sampling	Sediment	13	15	9	60%	11/10/2010	11/11/2010	3.060	197.006	1110.000	µg/kg
WA Ecology	Spokane River Sediment Bioassays and Chemical Analyses	Sediment	3	9	3	33%	8/7/1994	8/7/1994	21.000	1518.667	4500.000	µg/kg
WA Ecology	Pilot Study to Evaluate the Performance of a Prototype Stormwater Particulate Sampling Device	Stormwater Sediment	1	2	2	100%	1/31/2012	3/2/2012	166.447	178.732	191.018	µg/kg
WA Ecology	1992 Lakes Toxics Screening Survey	Fish	1	3	1	33%	8/26/1992	8/26/1992	724.000	724.000	724.000	µg/kg
WA Ecology	1992 Lakes Toxics Screening Survey	Sediment	2	3	0	0%	6/9/1992	6/9/1992				µg/kg
WA Ecology	Spokane River PCB Source Assessment 2003-2007 (formerly Spokane River PCB TMDL)	CSO	1	1	1	100%	6/10/2004	6/10/2004	0.083	0.083	0.083	µg/L
WA Ecology	Spokane River PCB Source Assessment 2003-2007 (formerly Spokane River PCB TMDL)	Fish	5	15	15	100%	9/15/2003	7/14/2004	0.873	75.544	253.091	µg/kg
WA Ecology	Spokane River PCB Source Assessment 2003-2007 (formerly Spokane River PCB TMDL)	Other Water	4	16	7	44%	10/21/2003	4/27/2004	0.000	0.002	0.007	µg/L
WA Ecology	Spokane River PCB Source Assessment 2003-2007 (formerly Spokane River PCB TMDL)	Sediment	12	34	34	100%	10/20/2003	6/9/2004	1.897	82.750	1000.000	µg/kg
WA Ecology	Spokane River PCB Source Assessment 2003-2007 (formerly Spokane River PCB TMDL)	Stormwater	3	3	3	100%	6/10/2004	6/10/2004	0.005	0.029	0.062	µg/L
WA Ecology	Spokane River PCB Source Assessment 2003-2007 (formerly Spokane River PCB TMDL)	Surface Water	3	3	2	67%	10/20/2003	11/3/2003	0.000	0.001	0.001	µg/L
WA Ecology	Spokane River PCB Source Assessment 2003-2007 (formerly Spokane River PCB TMDL)	Wastewater	2	7	6	86%	10/21/2003	4/26/2004	0.000	0.001	0.003	µg/L
WA Ecology	Persistent Organic Pollutants in Feed and Rainbow Trout from Selected Trout Hatcheries	Fish	3	3	2	67%	4/4/2005	6/15/2005	11.700	11.750	11.800	µg/kg
WA Ecology	Persistent Organic Pollutants in Feed and Rainbow Trout from Selected Trout Hatcheries	Sediment	2	2	1	50%	4/4/2005	4/4/2005	16.400	16.400	16.400	µg/kg

Author	Study Name	Media	Locations	Sampled	Detected	Detection Frequency	Earliest Sample Date	Latest Sample Date	Minimum Concentration	Average Concentration	Maximum Concentration	Units
WA Ecology	PCBs, PBDEs, and Selected Metals in Spokane River Fish, 2005	Fish	9	53	52	98%	8/22/2005	11/3/2005	15.500	247.396	3000.000	µg/kg
GeoEngineers, Inc. report to WA Ecology	Riverfront Park Spokane	Soil	5	5	2	40%	4/5/2016	11/29/2016	11.000	21.000	31.000	µg/kg
GeoEngineers, Inc. report to WA Ecology	Riverfront Park Spokane	Surface Water	1	1	0	0%	11/23/2016	11/23/2016				µg/L
US EPA Region X	US EPA 2005 Phase 1 Fish Tissue Sampling: RI/FS Upper Columbia River/Lake Roosevelt	Fish	1	25	25	100%	9/14/2005	10/22/2005	6.300	43.763	154.000	µg/kg
WA Ecology	EPA: Lake Roosevelt Assessment of Dioxins, Furans, and PCBs in Fish Tissue 1994	Fish	12	13	13	100%	7/11/1994	7/13/1994	2.600	11.485	24.100	µg/kg
WA Ecology	Freshwater Fish Contaminant Monitoring Program 2013	Fish	1	3	3	100%	10/8/2013	10/8/2013	6.700	53.233	118.000	µg/kg
Hart Crowser for Kaiser Aluminum	Kaiser Trentwood Remedial Investigation, Spokane, WA	Groundwater	103	1962	925	47%	1/23/2006	10/27/2016	0.001	0.311	28.000	µg/L
Hart Crowser for Kaiser Aluminum	Kaiser Trentwood Remedial Investigation, Spokane, WA	Soil	99	520	299	58%	2/8/2006	11/7/2013	2.200	15332.181	650000.000	µg/kg
GeoEngineers, Inc. report to WA Ecology	City Parcel	Soil	120	197	144	73%	6/29/2009	7/18/2014	41.500	166505.992	17000000.000	µg/kg
Kennedy/Jenks Consultants	BNSF Parkwater Railyard, Spokane, WA	Groundwater	4	4	0	0%	10/7/2008	10/8/2008				µg/L
Kennedy/Jenks Consultants	BNSF Parkwater Railyard, Spokane, WA	Soil	15	31	4	13%	12/3/2009	2/9/2010	54.800	140.950	200.000	µg/kg
Not Stated	FUDS Fairchild Nike 87	Soil	4	4	4	100%	6/11/1999	6/11/1999	21.900	135.475	240.000	µg/kg
Maul Foster & Alongi Inc.	Hutton Settlement, 521 East Sprague, Spokane, WA	Soil	2	2	0	0%	5/7/2014	5/8/2014				µg/kg
WA Ecology, General Electric	General Electric Co., Spokane	Groundwater	13	325	126	39%	1/4/1994	2/19/2003	0.003	0.264	2.075	µg/L
WA Ecology	Little Spokane River PCBs in Fish Tissue Verification Study	Fish	3	7	7	100%	10/22/2014	10/22/2014	3.990	35.470	62.892	µg/kg
WA Ecology	Little Spokane River PCBs in Fish Tissue Verification Study	Sediment	6	7	7	100%	10/21/2014	10/21/2014	0.584	2.174	3.951	µg/kg
WA Ecology	Spokane Fish Hatchery PCB Evaluation	Fish	2	8	8	100%	4/12/2016	9/23/2016	4.042	14.066	28.711	µg/kg
WA Ecology	Spokane Fish Hatchery PCB Evaluation	Sediment	3	7	7	100%	4/12/2016	10/11/2016	3.825	29.942	94.979	µg/kg
WA Ecology	Spokane Fish Hatchery PCB Evaluation	Water	2	9	9	100%	4/12/2016	10/11/2016	0.000	0.000	0.001	µg/L
WA Ecology	Evaluation of Candidate Freshwater Sediment Reference Sites	Sediment	6	6	1	17%	8/19/2008	8/21/2008	3.500	3.500	3.500	µg/kg
City of Spokane	PCBs in Municipal Products	Product	1	50	49	98%	9/19/2011	4/24/2015	0.064	57.731	2509.513	µg/kg
City of Spokane	Evaluation of PCBs in Deicer and Evaluation of PCBs in Traffic Marking Paint	Unknown	1	34	34	100%	1/20/2016	10/4/2016	0.000	0.146	1.745	µg/L
WA Ecology	West Medical Lake PCBs, Dioxins and Furans in Fish, Sediment, and Wastewater Treatment Plant Effluent	Fish	2	6	6	100%	4/11/2008	4/11/2008	12.000	24.333	44.000	µg/kg
WA Ecology	West Medical Lake PCBs, Dioxins and Furans in Fish, Sediment, and Wastewater Treatment Plant Effluent	Other Water	2	6	6	100%	2/13/2008	10/28/2008	0.000	0.000	0.000	µg/L
WA Ecology	West Medical Lake PCBs, Dioxins and Furans in Fish, Sediment, and Wastewater Treatment Plant Effluent	Sediment	7	8	8	100%	4/2/2008	4/3/2008	9.000	13.575	19.000	µg/kg
WA Ecology	Metals and PCBs in Long Lake Fish	Fish	2	47	40	85%	6/18/2001	6/19/2001	31.000	106.206	393.000	µg/kg
WA Ecology	Spokane River PCB and Source Survey, August 2000	Other Water	1	4	4	100%	8/14/2000	8/15/2000	0.002	0.006	0.012	µg/L
WA Ecology	Spokane River PCB and Source Survey, August 2000	Surface Water	6	12	12	100%	8/13/2000	8/13/2000	0.001	0.003	0.023	µg/L
WA Ecology	Spokane Area Point Source PCB Survey, May 2001	Other Water	5	9	9	100%	5/1/2001	5/2/2001	0.002	0.005	0.010	µg/L
WA Ecology	Spokane Area Point Source PCB Survey, May 2001	Sediment	2	4	3	75%	5/2/2001	5/2/2001	118.000	198.667	283.000	µg/kg
WA Ecology	Spokane River Sediments October 2000	Sediment	7	7	5	71%	10/23/2000	10/25/2000	2.000	570.740	1429.000	µg/kg
WA Ecology	Ecology PCBs Investigation Spokane River	Sediment	22	27	23	85%	7/26/1993	8/10/1994	3.600	605.939	4500.000	µg/kg
LimnoTech for Task Force	Spokane River Regional Toxics Task Force 2014 Synoptic Dry Weather Survey and Confidence Testing for PCBs in Surface Water	Wastewater	5	23	23	100%	8/13/2014	8/21/2014	0.000	0.003	0.023	µg/L
LimnoTech for Task Force	Spokane River Regional Toxics Task Force 2014 Synoptic Dry Weather Survey and Confidence Testing for PCBs in Surface Water	Water	7	65	65	100%	5/13/2014	8/24/2014	0.000	0.000	0.002	µg/L
LimnoTech for Task Force	Spokane River Regional Toxics Task Force 2015 Synoptic Dry Weather Survey	Wastewater	3	12	12	100%	8/18/2015	8/22/2015	0.000	0.002	0.004	µg/L
LimnoTech for Task Force	Spokane River Regional Toxics Task Force 2015 Synoptic Dry Weather Survey	Water	5	33	33	100%	8/18/2015	8/22/2015	0.000	0.000	0.000	µg/L
LimnoTech for Task Force	Spokane River Regional Toxics Task Force 2016 Monthly Monitoring	Water	6	35	35	100%	3/24/2016	12/13/2016	0.000	0.000	0.001	µg/L
WA Ecology	Spokane River Urban Waters-Liberty Lake Pilot Project	Other Water	4	5	5	100%	2/13/2009	2/19/2009	0.002	0.006	0.013	µg/L
WA Ecology	Spokane River Urban Waters-Liberty Lake Pilot Project	Stormwater	4	4	4	100%	11/7/2008	11/7/2008	0.001	0.005	0.009	µg/L
WA Ecology	Spokane River Urban Waters-Liberty Lake Pilot Project	Stormwater Sediment	3	3	3	100%	10/30/2008	10/30/2008	5.203	8.774	14.344	µg/kg
WA Ecology	Spokane River Urban Waters-Spokane River Source Trace Study Regarding PCB, PBDE, Metal, and Dioxin/Furan Contamination	CSO	3	7	7	100%	6/8/2009	7/13/2011	0.006	0.033	0.063	µg/L
WA Ecology	Spokane River Urban Waters-Spokane River Source Trace Study Regarding PCB, PBDE, Metal, and Dioxin/Furan Contamination	Landfill Leachate	1	1	0	0%	2/3/2010	2/3/2010				µg/L
WA Ecology	Spokane River Urban Waters-Spokane River Source Trace Study Regarding PCB, PBDE, Metal, and Dioxin/Furan Contamination	Other Water	6	10	10	100%	6/8/2009	8/29/2013	0.000	0.009	0.039	µg/L
WA Ecology	Spokane River Urban Waters-Spokane River Source Trace Study Regarding PCB, PBDE, Metal, and Dioxin/Furan Contamination	Sediment	26	32	31	97%	2/3/2010	8/29/2013	2.440	150.471	2988.100	µg/kg

Author	Study Name	Media	Locations	Sampled	Detected	Detection Frequency	Earliest Sample Date	Latest Sample Date	Minimum Concentration	Average Concentration	Maximum Concentration	Units
WA Ecology	Spokane River Urban Waters-Spokane River Source Trace Study Regarding PCB, PBDE, Metal, and Dioxin/Furan Contamination	Stormwater	25	52	51	98%	6/8/2009	5/13/2013	0.001	0.587	24.669	µg/L
WA Ecology	Spokane River Urban Waters-Spokane River Source Trace Study Regarding PCB, PBDE, Metal, and Dioxin/Furan Contamination	Stormwater Sediment	6	8	8	100%	6/25/2009	6/27/2012	4.630	1821.017	12917.600	µg/kg
WA Ecology	Spokane River Urban Waters-Spokane River Source Trace Study Regarding PCB, PBDE, Metal, and Dioxin/Furan Contamination	Wastewater	1	1	1	100%	6/7/2011	6/7/2011	0.000	0.000	0.000	µg/L
WA Ecology	Spokane River Urban Waters-Spokane River Source Trace Study Regarding PCB, PBDE, Metal, and Dioxin/Furan Contamination	Water	1	1	0	0%	2/11/2010	2/11/2010				µg/L
WA Ecology	Upriver Dam PCB Sediments Site	Sediment	34	43	27	63%	9/3/2003	10/7/2004	2.300	42.333	330.000	µg/kg
LFR Inc.	Stockland Livestock Exchange, Spokane, WA	Groundwater	1	1	1	100%	10/24/2006	10/24/2006	0.193	0.193	0.193	µg/L
LFR Inc.	Stockland Livestock Exchange, Spokane, WA	Soil	18	21	4	19%	10/23/2006	4/6/2007	6.810	34.045	61.000	µg/kg
LFR Inc.	Appleway Chevrolet Inc., Sales Lot (Facility Site No. 28314355 and VCP No. EA0148), Spokane, WA	Groundwater	4	16	0	0%	6/10/2008	12/9/2010				µg/L
The Riley Group	Martins Auto Service Trent Walgreens, Millwood, WA	Soil	23	23	1	4%	4/5/2007	4/18/2007	184.000	184.000	184.000	µg/kg
GeoEngineers, Inc.	Atlas Mine and Mill Supply Inc., Spokane, WA	Soil	58	58	19	33%	11/4/2005	2/1/2007	34.700	5495.147	29140.000	µg/kg
GeoEngineers, Inc.	Columbia Paint & Coatings, Spokane, WA	Soil	3	3	0	0%	11/5/1993	11/5/1993				µg/kg
Environmental Management Services LLC	City Ramp Garage UST 5015 Phase II ESA and Remediation, Spokane, WA	Soil	2	2	1	50%	10/15/2008	10/15/2008	600.000	600.000	600.000	µg/kg
Sierra Piedmont	United Parcel Service, Spokane, WA	Soil	2	2	0	0%	7/28/2010	7/28/2010				µg/kg
Fulcrum Environmental Consulting	Custer Commercial Center Soil Remediation, Spokane, WA	Soil	3	4	0	0%	8/3/2012	8/3/2012				µg/kg
Budinger and Associates	Spokane Convention Center Completion Project, Spokane, WA	Soil	6	6	0	0%	6/21/2013	6/26/2013				µg/kg
Budinger and Associates	CSO 33-2 (KAR BRITE), Spokane, WA	Other Water	1	1	0	0%	9/10/2014	9/10/2014				µg/L
Budinger and Associates	CSO 33-2 (KAR BRITE), Spokane, WA	Soil	3	3	0	0%	9/10/2014	10/2/2014				µg/kg
Budinger and Associates	CSO 33-2 (KAR BRITE), Spokane, WA	Stormwater	1	3	0	0%	2/23/2016	8/23/2016				µg/L
Budinger and Associates	Cheney Super Stop Lots 8 & 9, Cheney, WA	Groundwater	4	8	0	0%	4/9/2015	7/8/2015				µg/L
WA Ecology	WSPMP 1993 Pesticides in Fish Tissue	Fish	1	2	2	100%	7/27/1993	7/27/1993	720.000	975.000	1230.000	µg/kg
WA Ecology	Washington State Toxics Monitoring Program: Exploratory Monitoring 2001	Fish	1	2	2	100%	11/8/2001	11/8/2001	39.000	39.000	39.000	µg/kg
WA Ecology	Washington State Toxics Monitoring Program: Exploratory Monitoring 2002	Fish	1	2	2	100%	10/23/2002	10/23/2002	36.000	36.000	36.000	µg/kg
WA Ecology	Washington State Toxics Monitoring Program: Exploratory Monitoring 2003	Fish	3	19	10	53%	9/17/2003	10/23/2003	2.100	9.410	33.000	µg/kg
WA Ecology	Washington State Toxics Monitoring Program: Pre-QAPP Trend Monitoring	Fish	1	25	25	100%	9/16/2003	9/16/2003	9.697	28.751	74.516	µg/kg
WA Ecology	Washington State Toxics Monitoring Program: Exploratory Monitoring 2005	Fish	2	7	4	57%	8/23/2005	10/11/2005	10.159	17.480	24.800	µg/kg
WA Ecology	Washington State Toxics Monitoring Program: Exploratory Monitoring 2006	Fish	1	8	4	50%	9/27/2006	9/27/2006	2.400	4.296	6.192	µg/kg
WA Ecology	Washington State Toxics Monitoring Program: Exploratory Monitoring 2008	Fish	1	4	4	100%	11/18/2008	11/18/2008	1.010	1.193	1.375	µg/kg
WA Ecology	Washington State Toxics Monitoring Program: Exploratory Monitoring 2009	Fish	2	5	0	0%	10/12/2009	10/14/2009				µg/kg
WA Ecology	Washington State Toxics Monitoring Program: Exploratory Monitoring 2012	Fish	7	91	84	92%	9/19/2012	11/5/2012	11.000	91.595	370.000	µg/kg

Notes:

CSO = Combined Sewer Overflow; PCB = Polychlorinated Biphenyl; Task Force = Spokane River Regional Toxics Task Force; WA Ecology = Washington State Department of Ecology.

Attachment 3

Background on Byproduct PCBs

Table of Contents

Page

List of Tables

****Embedded in text.***

List of Charts

**All Charts are embedded in the text.*

A3.1 Introduction

Byproduct polychlorinated biphenyls (PCBs) (also referred to as "inadvertently generated" PCBs) are PCBs that are produced as a byproduct during certain industrial processes, particularly in pigment production, but also a variety of other industrial processes that combine carbon, chlorine, and high temperatures. Recent studies have drawn attention to the presence of byproduct PCBs in consumer products (Rodenburg *et al*., 2010; Hu and Hornbuckle, 2010), as well as in various environmental media (Hu *et al*., 2008; Guo *et al*., 2014), including at remote locations (Pizzini *et al*., 2017).

The presence of PCBs in pigments was known at the time the Toxic Substances Control Act (TSCA) was promulgated in 1979 (US EPA, 1979a) and shortly thereafter, the United States Environmental Protection Agency (US EPA) identified around 200 chemical synthesis processes that had the potential to create PCBs as a byproduct. These chemical synthesis processes combined carbon, chlorine, and high temperatures (US EPA, 1983) and were not only used to produce various industrial chemicals (*e.g*., chlorinated methanes and ethanes) and precursors (*e.g*., silanes used to manufacture silicone), but also chemicals that are ingredients in consumer products (*e.g*., glycerol). As a result, products that may contain byproduct PCBs include not only inks, paints, and dyes, but also agricultural chemicals, plastics, and detergent bars (US EPA, 2011). Byproduct PCBs can also be formed during combustion through various pathways, including direct chlorination, radical coupling, and/or *de novo* synthesis[1] (Ballschmiter *et al*., 1987; Jiang *et al*., 2015). At least 142 individual PCB congeners have been associated with these various processes, as depicted in Chart A3.1.

In the Final Rule dealing with exemptions for byproduct PCBs in products, published in 1984 (US EPA, 1984), US EPA subsequently established allowable concentration limits for byproduct PCBs in products manufactured or imported in the US[2] (<50 parts per million [ppm] maximum, <25 ppm annual average), as well as emission limits at the point of release to water and air. The limits are for total PCBs, calculated based on the individual congener concentrations, after division by factors of 50 and 5 for mono- and dichloro- congeners, respectively (US EPA, 1983). These discounting factors were proposed based on evidence that mono- and dichloro- PCB congeners were not found in adipose tissue and were less persistent and bioaccumulative than the higher chlorinated congeners (US EPA, 1983).

Similar allowances for byproduct PCBs exist internationally. For example, both the European Union (EU) and Canada established a limit of 50 ppm for the sum of PCBs in pigments, but without any discounting factors (US EPA, 2008; Rodenburg *et al*., 2015). In addition, Canada also specifies a yearly average of 25 ppm per pigment that a person may manufacture, export, import, offer for sale, sell, process, or use (US EPA, 2008).

[1] *De novo* synthesis is a term used to describe the formation of complex molecules from very simple starting materials. In the case of PCBs, this refers to formation from carbon and chlorine, as opposed to more complex precursors such as chlorobenzene.
[2] Consumer products with a high exposure potential (specifically detergent bars) have an allowable limit of 5 ppm.

Homolog Group	Individual Congeners																																													
mono	1	2	3
di	4	5	6	7	8	9	10	11	12	13	14	15
tri	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39
tetra	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81
penta	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127
hexa	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169
hepta	170	171	172	173	174	175	176	177	178	179	180	181	182	183	184	185	186	187	188	189	190	191	192	193
octa	194	195	196	197	198	199	200	201	202	203	204	205
nona	206	207	208
deca	209

Chart A3.1 Congeners Associated with Various Byproduct PCB Processes. PCB = Polychlorinated Biphenyl. Congeners are grouped by homolog group. Blue highlighting = Detection of congener in connection to at least one byproduct PCB process. Sources: Hu and Hornbuckle (2010); Anezaki *et al*. (2014); Anezaki and Nakano (2013, 2014, 2015); WA Ecology (2014a); Perdih and Jan (1994); Law (1995); Shang *et al*. (2014); Huang *et al*. (2015); Liu *et al*. (2013a); Liu *et al*. (2013b); Ishikawa *et al*. (2007); Jiang *et al*. (2015); Kim *et al*. (2004); Takasuga *et al*. (2014).

A3.2 Processes Associated with Byproduct PCBs

Byproduct PCBs are associated with the production of organic pigments,[3] the production of the inorganic pigment titanium oxide, and numerous other chemical manufacturing and combustion processes. A variety of industrial processes that combine carbon, chlorine, and heat have the potential to produce PCB byproducts (*e.g.*, production processes of numerous organic chemicals, notably glycerol, silicone derivatives, and various chlorinated organics [US EPA, 1983]; iron sintering; iron, steel, and copper production [Munoz, 2007]); however, there is significantly less information available on the specific congener distribution and concentrations associated with these other processes. Byproduct PCBs associated with the production of organic and inorganic pigments, other chemical manufacturing and combustion processes, and the studies that have analyzed them, are discussed in the following sections.

A3.2.1 Pigments

Pigment production has been identified as a source of byproduct PCBs due to use of certain chlorine-containing raw materials or chlorinated solvents. A wide variety of congeners have been detected in pigments or linked to their production processes; this variability may be due to differences in starting materials and/or manufacturing conditions. Table A3.1 illustrates detected congeners by pigment category and Chart A3.2 summarizes the congener detections grouped by homolog group. The remainder of this section summarizes the scientific understanding of the sources of these congeners in organic pigments (Section A3.2.1.1) and inorganic pigments (Section A3.2.1.2).

[3] Pigment is a colored substance that is used in the coloration of paints, printing inks, and plastics, and other substrates including but not limited to paper, textiles, cosmetics, and building materials. Unlike dyes, pigments are insoluble in their application medium. Pigments are used in paints and, because organic pigments have stronger coloring power, blending ratios are lower for organic pigments relative to inorganic pigments (Anezaki *et al*., 2014).

Homolog Group	Individual Congeners																																													
mono	1	2	3																																											
di	4	5	6	7	8	9	10	11	12	13	14	15																																		
tri	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39																						
tetra	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81				
penta	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127
hexa	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169				
hepta	170	171	172	173	174	175	176	177	178	179	180	181	182	183	184	185	186	187	188	189	190	191	192	193																						
octa	194	195	196	197	198	199	200	201	202	203	204	205																																		
nona	206	207	208																																											
deca	209																																													

Chart A3.2 Congeners Associated with Various Pigment Production Processes. Congeners are grouped by homolog group. Blue highlighting = Congener detected in at least one pigment sample. Sources: See Table A3.1.

A3.2.1.1 Organic Pigments

PCB 11 (3,3'-dichlorobiphenyl) is commonly cited as a pigment-related congener (*e.g.*, Vorkamp, 2016 and references within). PCB 11 is associated with the manufacturing of diarylide pigments (typically yellow) and is thought to originate from the use of 3,3'-dichlorobenzidine (dichlorobenzene [DCB]) as a precursor (Herbst *et al*., 2004; Hu and Hornbuckle, 2010; WA Ecology, 2014b). Other congeners commonly associated with diarylide pigments include PCBs 52 and 77 (Anezaki and Nakano, 2014). Alternatives for diarylide pigments have been evaluated not only due to concerns over PCB byproduct formation, but also because of the toxicity of the DCB precursor. DCB requires special handling during the manufacturing process (WA Ecology, 2014b) and may also be produced and released from pigments during high temperature applications (*e.g.*, in thermoplastics) due to degradation (Christie, 2013, 2016; Rodenburg *et al*., 2015). Diarylide pigments have been the dominant pigments used for yellow colors in printing inks for nearly a century, and there is currently little evidence of PCB-free pigment alternatives that can match their color and transparency requirements (Christie, 2013; WA Ecology, 2014b).

A variety of congeners have also been detected in other azo-type pigments, such as Napthol AS; these azo-type pigments are a class of pigments made using di- and trichlorinated anilines as starting materials (WA Ecology, 2014b; Anezaki *et al*., 2014; Table A3.1). The dominant congeners in these pigments are the tetra- and hexachlorinated congeners such as PCBs 52, 146, 149, or 153, and the substitution pattern on these congeners (*i.e*., 2 or 3 chlorine atoms on each ring) suggests that the PCBs are produced though radical coupling reactions[4] of the di- and trichlorinated aniline precursors (Anezaki *et al*., 2014). Azo pigments include certain red pigments that are used in printing inks, paints, and plastics, and there are currently no inorganic or organic pigment substitutes that are of comparable performance and cost (Christie, 2013). Options for reducing the amount of PCBs in the pigments include selective extraction with solvents or degradation of PCBs from the pigment matrix, but according to industry patents, these processes are not feasible because they affect pigment properties (Rieper, 1993). Instead, industry patents indicate that the most feasible option for minimizing the amount of PCBs created would be to make changes to the synthesis process (Rieper, 1993), but it is not clear if these changes have been implemented by the industry.

Penta- and hexachlorinated biphenyls have also been identified in phthalocyanine blue and have been linked to the use of chlorobenzene as a solvent during synthesis (Uyeta *et al*., 1976). Highly chlorinated PCBs such as nona- or decachlorinated congeners have been identified in phthalocyanine green, which is obtained by the perchlorination of phthalocyanine blue (Uyeta *et al*., 1976; Hu and Hornbuckle, 2010). Phthalocyanine blue and green are widely used in paints, printing inks, and plastics due to their excellent color and technical performance, and they do not appear to have comparable alternatives (WA Ecology, 2014b). Alternative manufacturing methods have been proposed for phthalocyanine using chlorine-free solvents or a solvent-free dry-bake process (WA Ecology, 2014b), but the process involving chlorobenzene as a solvent appears to be the most frequently used worldwide (Vorkamp, 2016). Similarly, chlorine-free green pigments are being investigated, but the current alternatives (chromium oxide, dye complex pigment) are not comparable in performance to phthalocyanine green (Christie, 2013).

Several mono- through tetrachlorinated congeners have been detected in samples of dioxazine pigments and diketopyrrolopyrrole pigments. The use of *o*-dichlorobenzene as a solvent during the manufacturing of certain dioxazine pigments was linked to production of di- and tetrachloro- congeners with chlorine atoms on opposite rings (*e.g.*, PCBs 5, 12, 40, 56, and 77 [Anezaki and Nakano, 2013]). Similarly, the use of the chlorinated precursor *p*-chlorobenzonitrile is thought to be involved in the production of byproduct

[4] "Radical coupling reaction" is a term used to describe the combination of two unstable radical species to form a stable larger molecule. In the context of PCB formation, the radical species are chlorinated species with one benzene ring, which couples to form the two-benzene PCB molecules.

PCBs associated with diketopyrrolopyrrole pigments (*e.g.*, PCBs 4, 6, 8, 11, 13, and 15 [Anezaki and Nakano, 2013).

A variety of PCB congeners have been linked to the manufacturing of other organic pigments with unspecified or unknown structures. For example, PCBs 11, 35, 77, and 126 have been identified in effluent wastewater streams from pigment factories (Litten *et al*., 2002), and PCBs 11 and 36 have been identified in sediments downstream of pigment production plants (Law, 1995). In addition, over 40 congeners were detected in a survey of commercial proprietary pigments used in consumer paints (Table A3.1; Hu and Hornbuckle, 2010).

A3.2.1.2 Inorganic Pigments

The production of titanium oxide *via* the chloride process involves the reactions of chlorine and carbon at high temperatures and is, therefore, believed to produce highly chlorinated congeners such as PCBs 206, 208, and 209. Praipipat *et al*. (2013) found evidence that the presence of these three congeners in Delaware River sediments originated from the operations of a titanium chloride plant. WA Ecology (2014a) has measured PCB 209 in a commercial titanium oxide colorant sample at 1.26 ppb and found evidence for the presence of PCBs 206 and 208, but their levels were very close to the method detection limit of 0.044 ppb. PCB 209 has been measured at concentrations of 0.2-0.25 ppb in white traffic paint (SWWM, 2015), although PCB 209 was below detection in the white pigment samples investigated by Hu and Hornbuckle (2010), despite both studies having similar detection limits. WA Ecology (2016) also detected several lower-molecular-weight congeners, such as PCBs 1, 2, 3, 7, 9, 11, 12/13, 14, 44/47/65, 79, and 80 (Table A3.1), in other samples of white paint.

Recently, a variety of other congeners were detected at concentrations of 9.4-843 ppb in white titanium dioxide-based pigment (Ctistis *et al*., 2016; Table A3.1). Congeners with higher degrees of chlorination and ortho- substitutions were found to be more abundant. In the same study, the authors also measured PCB levels in titanium dioxide nanoparticles, which are used in pigments and inks, as well as in cosmetics, food additives, fibers, and rubber (Ctistis *et al*., 2016). The authors suggested that PCBs may be present in titanium dioxide nanoparticles, but the exact concentrations could not be quantified[5] (Ctistis *et al*., 2016).

Titanium oxide can also be manufactured *via* the sulfate process (as opposed to the chloride process), and this route has not been associated with byproduct PCB generation. However, the chloride process is preferred in the pigment industry and accounted for 60% of the market in 2014 (Gazquez *et al*., 2014).

A3.2.2 Metallic Titanium

Like titanium dioxide production, the production of metallic titanium also involves the reaction of chlorine and coke at high temperatures, and therefore has the potential to produce byproduct PCBs. Chlorination transforms metals from titanium ore into metal chlorides, which can then be separated from the titanium chloride by condensation. The metal chloride byproducts can contain byproduct PCBs and can be sold for other applications. For example, ferric chloride reportedly used as a flocculent in wastewater treatment was the suspected source of PCB 209 detected in the New York/New Jersey Harbor (Panero *et al.*, 2005) and in the Philadelphia region of the Delaware River (Du *et al*., 2008). Magnesium chloride is also a common byproduct of titanium production that has been found to contain PCBs (Vorkamp, 2016). Magnesium chloride is used as a deicer and dust suppressant in the City of Spokane; however, the salt used

[5] Ctistis *et al*. (2016) report results as "less than" for all PCBs measured in nanoparticles, but the authors state that their results show that PCBs were present in titanium nanoparticles. Thus, it is not clear how the PCB results should be interpreted – if PCBs are less than the detection limit or if they were present but could not be confidently quantified.

in the Spokane municipal products is sourced from naturally occurring minerals in the Great Salt Lake and does not appear to contain highly chlorinated PCBs[6] (SWWM, 2015).

A3.2.3 Silicone Products and Precursors

Byproduct PCBs have also been detected in silicone-based glues (Anezaki and Nakano, 2013), silicone rubbers (Perdih and Jan, 1994), and silicone tubing (Cargill, 2014; Rodenburg, 2012, 2016). Congener patterns in silicone-based glues are dominated by PCBs 2 and 3, but PCB 1 has also been detected, along with several dichlorinated congeners (*i.e.*, PCBs 4, 6, 11, 13, and 15 [Anezaki and Nakano, 2013, 2015]). Additional details on congeners detected in silicone products and silicone precursors are presented in Table A3.2. The source of the detected congeners in silicone products and their precursors is believed to be the dimerization of chlorobenzene (Anezaki and Nakano, 2015), which is one possible precursor for silicone-based glues. Although chloromethane can also be used instead of chlorobenzene to make methyl-silicones (instead of phenyl-silicones), byproduct PCBs are expected to be associated mainly with silicones made using chlorobenzene (*i.e.*, phenylsilanes) instead of chloromethane (Anezaki and Nakano, 2015).

[6] In the Spokane municipal products study, magnesium chloride (*i.e.*, DustGuard) had total PCBs of 3.574 ppb, and the PCB load was made up of mostly PCBs 50 and 53.

Homolog Group	Individual Congeners																																													
mono	1	2	3																																											
di	4	5	6	7	8	9	10	11	12	13	14	15																																		
tri	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39																						
tetra	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81				
penta	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127
hexa	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169				
hepta	170	171	172	173	174	175	176	177	178	179	180	181	182	183	184	185	186	187	188	189	190	191	192	193																						
octa	194	195	196	197	198	199	200	201	202	203	204	205																																		
nona	206	207	208																																											
deca	209																																													

Chart A3.3 Congeners Associated with Silicone and Silicone Precursor Production. Congeners are grouped by homolog group. Blue highlighting = Congener detected in at least one sample. Sources: See Table A3.2.

The presence of byproduct PCBs in phenylchlorosilanes was known as early as 1979, when one of the manufacturers petitioned the US EPA for an exemption that would allow the manufacturer to continue manufacturing phenylchlorosilanes with PCB impurities greater then 50 ppm (US EPA, 1979b). According to the same document, phenylchlorosilane is a precursor used for manufacturing high-performance silicone products for various industrial, aerospace, and defense applications (US EPA, 1979b).

Although similar congener distribution patterns were found in organotins (*e.g.*, chlorophenyltin, trichlorophenyltin), which are catalysts used in manufacturing silicone-based glues (Anezaki and Nakano, 2013), the congener levels were significantly lower in the organotin than in the silicone-based glues (Anezaki and Nakano, 2013). As a result, organotin compounds were not considered to be the likely source of the detected byproduct PCBs in silicone-based glues.

The congeners most frequently associated with silicone tubing include PCBs 44 and 45[7] (Cargill, 2014; Rodenburg, 2012; Leidos, 2016), but also PCB 68 (Rodenburg, 2016; Leidos, 2016). In a separate investigation by Perdih and Jan (1994), who tried to understand the mechanism of byproduct PCB formation, a variety of congeners were detected in silicone rubber samples, including PCBs 8, 4/10, 33, 18, 16, 17 and 47/48/49. This latter set of congeners is believed to be produced from the use of the crosslinker bis(2,4-dichlorobenzoyl)peroxide, but the exact mechanism is not known (Perdih and Jan, 1994).

A3.2.4 Synthesis of Various Organic Chemicals

According to the Chemical Manufacturers Association, "PCBs can be generated from virtually any starting hydrocarbon structure," and "PCB formation appears to be possible whenever chlorine and carbon are present in a reaction vessel at elevated temperatures" (US EPA, 1982).

During the rulemaking process regarding exemptions for byproduct PCBs, US EPA identified approximately 200 chemical products or chemical compound classes with the potential for byproduct PCB generation (Cristol, 1983). Out of these, over 70 chemicals were ranked to have high potential for byproduct PCB generation (Table A3.3), including both halogenated compounds (such as chlorinated benzenes, chlorinated or brominated ethanes and ethylenes, aluminum chloride) and compounds that lack halogen atoms (*e.g.*, glycerol, ethylene diamine). Some of the chemical products identified in Table A3.3 are used in consumer products (*e.g.*, glycerol), while many are chemical intermediates (*e.g.*, epichlorohydrin, which is used in the production of epoxy resins) or industrial solvents (*e.g.*, chlorinated ethylenes). There are little data available on the concentration or congener distributions of PCBs in the resulting chemicals (Callahan *et al.*, 1983).

[7] When using SPB® columns for analytical separation of PCBs, the congeners PCB 44 and PCB 45 correspond to the pairs PCB 47/44/65 and PCB 51/45 due to coelutions (Rodenburg, 2016). SPB® columns are one type of chromatography column that can be used when analyzing PCBs. The choice of column ultimately impacts the separation of the congeners into individual peaks and presence of coelution pairs.

Table A3.3 Chemicals with a High Potential to Generate Byproduct PCBs During Their Production, as Determined by US EPA

Compounds or Compound Classes	
Allyl Alcohol	Chlorinated Fluorinated Methanes
Allyl Amines	Chlorinated Methanes:
Aluminum Chloride	Carbon Tetrachloride
Aminochlorobenzotrifluoride	Chloroform
Aminoethylethanolamine	Methyl Chloride
Benzene Phosphorus Dichloride	Methylene Chloride
Benzophenone	Chlorinated Naphthalenes
Benzotrichloride	Chlorinated Pesticides
Benzoyl Peroxide	Chlorinated Pigments/Dyes
Carbon Tetrabromide	Chlorinated Propanediols
Carbon Tetrafluoride	Chlorinated Propanols:
Chlorendic Acid/Anhydride/Esters	Dichlorohydrin
Chlorinated Acetophenones	Propylene Chlorohydrin
Chlorinated Benzenes:	Chlorinated Propylenes
Dichlorobenzenes	Chlorinated Unsaturated Paraffins
Hexachlorobenzenes	Chlorobenzaldehyde
Monochlorobenzene	Chlorobenzoic Acid/Esters
Pentachlorobenzene	Chlorobenzoyl Peroxide
1,2,4,5-Tetrachlorobenzene	Chlorobenzyl Hydroxyethyl Sulfide
Trichlorobenzene	Chlorobenzyl Mercaptan
Chlorinated Benzotrichlorides	bis (2-Chloroisopropyl) Ether
Chlorinated Benzotrifluorides	Dimethoxy Benzophenone
Chlorinated Benzylamines	Dimethyl Benzophenone
Chlorinated Brominated Ethylenes	Diphenyl Oxide
Chlorinated Brominated Methanes	Epichlorohydrin
Chlorinated Ethanes:	Ethylene Diamine
1,1-Dichloroethane	Glycerol
1,2-Dichloroethane	Hexachlorobutadiene
Hexachloroethane	Hexachlorocyclohexane
Monochloroethane	Hexachlorocyclopentadiene
1,1,2,2-Tetrachloroethane	Linear Alkyl Benzenes
1,1,1-Trichloroethane	Methallyl Chlorides
1,1,2-Trichloroethane	Pentachloronitrobenzene
Chlorinated Ethylenes:	Phenylchlorosilanes
1,1-Dichloroethylene	o-Phenylphenol
1,2-Dichloroethylene	Phosgene
Monochloroethylene	Propylene Oxide
Tetrachloroethylene	Tetrachloronaphtalic Anhydride
Trichloroethylene	Tetramethylethylene Diamine
Chlorinated Fluorinated Ethanes	Trichlorophenoxy Acetic Acid
Chlorinated Fluorinated Ethylenes	

Notes:
PCB = Polychlorinated Biphenyl; ppm = Parts Per Million; US EPA = United States Environmental Protection Agency.
Shaded Chemicals = Those identified to contain more than 50 ppm PCB concentration at the point of manufacture based on petitions submitted to US EPA (Callahan *et al.*, 1983).
Adapted from Callahan *et al.* (1983).

Out of the 200 chemical products with the potential to produce byproduct PCBs, multiple were identified to contain more than 50 ppm PCB concentration at the point of manufacture (Table A3.3). This was determined by the US EPA based on exemption petitions submitted by companies after TSCA PCB action in 1979, which allowed byproduct PCB production less than 50 ppm but required a petition application when concentrations in products exceeded 50 ppm. These chemicals are shaded grey in Table A3.3 (Callahan *et al*., 1983). Other specific products for which exemption petitions were filed include polysiloxane intermediate and silicone diffusion pump fluids, phthalocyanine blue and green pigments, diarylide yellow and orange pigments, and alkylated dichlorobenzene (Callahan *et al*., 1983).

There is limited information available on the congener fingerprints associated with the majority of the processes identified by the US EPA as having a potential to produce byproduct PCBs (Table A3.3). Although some research groups have measured PCBs in some of these chemicals, the analyses have been mostly focused on dioxin-like PCBs (dl-PCBs) or homologs. When available, congener and homolog sampling information from these chemicals is summarized in Table A3.2 and in Chart A3.4. The following sections summarize the information available in the scientific literature on selected chemical categories linked to byproduct PCB production.

Homolog Group	Individual Congeners																																													
mono	1	2	3																																											
di	4	5	6	7	8	9	10	11	12	13	14	15																																		
tri	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39																						
tetra	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	**77**	78	79	80	**81**				
penta	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112	113	**114**	115	116	117	**118**	119	120	121	122	**123**	124	125	**126**	127
hexa	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	**156**	**157**	158	159	160	161	162	163	164	165	166	**167**	168	**169**				
hepta	170	171	172	173	174	175	176	177	178	179	180	181	182	183	184	185	186	187	188	**189**	190	191	192	193																						
octa	**194**	195	196	197	198	199	200	201	202	203	204	205																																		
nona	**206**	207	208																																											
deca	**209**																																													

Chart A3.4 Congeners Associated with the Production of Industrial Chemicals Such as Halogenated Solvents and Pesticides. Congeners are grouped by homolog group. Blue highlighting = Congener detected in at least one sample. Sources: See Table A3.2.

A3.2.4.1 Halogenated Solvents

Some early studies (Erickson *et al*., 1988) reported that mono- and dichlorinated congeners were present in samples of vinyl chloride monomer, and that nona- and decachlorobiphenyl were identified in still bottoms from the manufacturing of tetrachloroethenes. A more-recent study (Liu *et al*., 2004) investigated PCB levels in *p*-dichlorobenzene, a compound widely used in mothballs, room deodorizers, and urinal and toilet blocks. This study measured dl-PCBs and total PCBs as homologs and found that mono- through pentachlorinated PCBs were present in the purified *p*-dichlorobenzenes, as well as in other chemicals produced through the same process (*e.g*., *o*-dichlorobenzene and 1,2,4-trichlorobenzene) (Liu *et al*., 2004). The presence of PCBs in the chlorinated benzenes was understandable given that (1) the production process of PCBs is very similar to that of chlorinated benzenes (*i.e*., involves progressive chlorination of the hydrocarbon substrate in the presence of a ferric chloride catalyst), and (2) the purification process can remove other inadvertently produced compounds such as polychlorinated dibenzodioxins (PCDDs), but is minimally effective at removing the byproduct PCBs (Liu *et al*., 2004).

A3.2.4.2 Pesticides

PCBs have also been measured in selected agricultural chemicals, such as the fungicides pentachloronitrobenzene (Huang *et al*., 2015) and chloranil (Liu *et al.*, 2012), the herbicides 2,4-D acid and 2,4-D butyl ester (Liu *et al*., 2013a; Masunaga *et al*., 2001), and five other pesticides (Table A3.2; Masunaga *et al*., 2001). These investigations focused on dl-PCBs, which were all typically detected (Table A3.2). For pentachloronitrobenzene, Huang *et al*. (2015) also reported homolog profiles, which were dominated by penta- through nonachlorinated homologs and detections of a few indicator PCBs, such as PCBs 194, 206, and 209. In addition to its use as a fungicide, chloranil is also used as a chemical intermediate for the synthesis of pharmaceuticals, pesticides, and dyes (Liu *et al.*, 2012).

A3.2.4.3 Chlorinated Paraffins

Byproduct PCBs were also linked to the production of chlorinated paraffins, which are used as coolants and lubricants in metal forming and cutting and as plasticizers and flame retardants in rubbers, plastics, sealants, and other materials. Takasuga *et al*. (2012) reported that the homolog fingerprint of PCBs in chlorinated paraffins was dominated by lower chlorinated homologs (mono-, di-, and trichlorobiphenyls), but did not report any congener-level analyses (Table A3.2).

A3.2.5 Combustion

PCBs can also be formed inadvertently during combustion, alongside other chemicals, such as PCDDs and polychlorinated dibenzofurans (PCDFs), chlorinated naphthalenes, and polybrominated dibenzo-p-dioxins and dibenzofurans. Historically, research has focused on characterizing the emissions to air of PCDD/Fs and more recently dl-PCBs, with the goal of establishing emission factors on a toxicity equivalent basis. As such, dl-PCBs have been measured in emissions and fly ash from waste incinerators (Sakai *et al*., 1994), iron ore sintering (Tian *et al*., 2012; Li *et al*., 2017), coke ovens (Cui *et al*., 2013), cement kilns, and primary and secondary metal processing (Takasuga *et al*., 2014). All dl-PCBs were above detection limits in these studies, and PCBs 77, 105, and 118 appear to be the dominant dl-PCBs (Li *et al*., 2017; Cui *et al*., 2013; Liu *et al*., 2013b).

Homolog Group	Individual Congeners																																													
mono	1	**2**	**3**																																											
di	4	5	6	7	8	9	10	**11**	**12**	**13**	**14**	**15**																																		
tri	16	17	18	19	**20**	**21**	22	23	24	25	26	27	**28**	29	30	31	32	**33**	34	**35**	36	**37**	**38**	39																						
tetra	**40**	41	42	43	44	45	46	47	48	49	50	51	**52**	53	54	55	56	**57**	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	**77**	**78**	**79**	80	**81**				
penta	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	**101**	102	103	104	**105**	106	**107**	**108**	109	110	111	112	113	**114**	115	116	117	**118**	119	120	121	**122**	**123**	124	125	**126**	**127**
hexa	128	**129**	130	131	132	133	134	135	136	137	**138**	139	140	141	142	143	144	145	146	147	148	149	150	151	152	**153**	154	155	**156**	**157**	158	159	160	161	162	163	164	165	166	**167**	168	**169**				
hepta	**170**	171	**172**	173	174	175	176	177	178	179	**180**	181	182	183	184	185	186	187	188	**189**	190	191	**192**	193																						
octa	**194**	**195**	**196**	197	198	199	200	201	202	**203**	204	**205**																																		
nona	**206**	207	208																																											
deca	**209**																																													

Chart A3.5 Congeners Associated with Combustion. Congeners are grouped by homolog group. Blue highlighting = Congener detected in at least one study. Sources: See Table A3.2.

The formation of PCBs and other chlorinated compounds is believed to occur mainly in the cooling zone of combustors and smelters, *via* heterogeneous catalysis on the fly ash surface (Jiang *et al*., 2015). PCB formation may occur through multiple pathways, including direct chlorination, radical coupling, and/or *de novo* synthesis[8] (Ballschmiter *et al*., 1987; Jiang *et al*., 2015). PCBs from combustion sources can also originate from incomplete combustion of PCBs in the feed materials, which can occur at lower combustion temperatures (<800ºC [Kim *et al*., 2004]).

The formation of PCBs is favored by the presence of carbon, chlorine-containing compounds, and certain metals such as copper or iron. These factors have been shown to influence the distribution of congeners that are produced from combustion. For example, higher chlorine content or the presence of copper or iron in the feed has been correlated with an increase in octa- through decachlorinated biphenyls in stack gases (Liu *et al*., 2013b; Ishikawa *et al*., 2007). The homolog distribution formed by various processes can be variable nonetheless (Table A3.2), and stack emissions can ultimately be influenced by the specific air pollution control technologies employed.

While other congeners may also be formed during combustion, the majority of studies have targeted dl-PCBs in sampling (Table A3.2). Some studies have found dl-PCBs to be more abundant than other congeners (Kim *et al*., 2005; Takasuga *et al*., 1994); this is thought to be because the formation of non-ortho and mono-ortho PCBs is favored during combustion due to steric hindrance[9] (Sakai *et al*., 1994).

A variety of other congeners besides dl-PCBs have been detected in flue gases from waste incinerators, cement kilns, and other thermal sources (Kim *et al*., 2004; Takasuga *et al*., 2014). Kim *et al*. (2004) reported that, with the exception of PCB 112, all 209 congeners were detected in flue gases from eight incinerators from Japan. The type of waste incinerated included municipal waste, medical waste, plastic waste, sludge, saw dust, waste solvent, and wastewater sludge; however, the authors did not measure PCB levels in any of the feed materials. Combustion-specific congeners include the non-ortho dl-PCBs 77, 81, 126, and 169, as well as other congeners such as PCBs 38, 40/57, 170, and 206 (Kim *et al*., 2004), as well as several mono- and dichlorinated congeners such as PCBs 2, 3, 12/13, 14, and 11 (Takasuga *et al*., 2014).

The production of dl-PCBs has also been associated with fumes produced from cooking beef (Dong *et al*., 2011). The production of PCBs was enhanced by the presence of sucralose or chloropropanols in the raw beef, which are common food additives that contain chlorine atoms in their structure. The byproduct PCBs were mostly associated with the fumes, and levels of dl-PCBs decreased in the cooked relative to uncooked beef (Dong *et al*., 2011). Only 12 dl-PCBs were quantified in this study, and PCBs 77, 105, 118, 126, and 157 were the most abundant dl-PCBs in oil fumes (Dong *et al*., 2011) .

Chlorination of wastewater is another possible source of byproduct PCBs, as suggested by studies of the chlorination of biphenyl in wastewater treatment conditions (Ontario Ministry of the Environment, 1975). However, Ontario Ministry of the Environment (1975) and subsequent studies (Vorkamp, 2016) have shown that the formation of PCBs from chlorination of biphenyl is inhibited by the presence of ammonia and that sorption and degradation of biphenyl are also expected to reduce reaction rates.

[8] *De novo* synthesis is a term used to describe the formation of complex molecules from very simple starting materials. In the case of PCBs, this refers to formation from carbon and chlorine, as opposed to more complex precursors such as chlorobenzene.

[9] Steric hindrance occurs when large atoms are found in close proximity to each other during the formation of a chemical product. One such example is when two or more chlorine atoms are present at the ortho positions of two biphenyl rings. Due to steric hindrance, the formation of PCBs with several chlorine atoms at the ortho position may be less favorable than other configurations.

A3.3 Byproduct PCBs in Products

Several recent studies have focused on sampling finished consumer and municipal products to determine whether byproduct PCBs are present therein. Literature studies (Rodenburg *et al*. 2010, Guo *et al*. 2014) on consumer products found total PCB concentrations ranging from <1 to 100s of ppb. Two additional studies have focused on consumer products used in Washington State (WA Ecology, 2014a, 2016), and other studies targeted municipal products used in the Spokane area (SWWM, 2015; SRRTTF, 2015). While some of the studies discussed below focused on linking the PCB detections to certain ingredients in the products, others were limited to measuring bulk product concentration and fingerprint analysis.

Although pigments were most often the likely ingredient responsible for the measured PCBs, other sources such as silicones, polychlorinated napthalenes, or other organic chemicals, were also suspected.

A3.3.1 Byproduct PCBs in Paint Pigments

Multiple studies have investigated the presence of byproduct PCBs in commercial paint pigments purchased in the US as well as overseas. The concentrations of total PCBs varied by several orders of magnitude (Table A3.4). In the US study, Hu and Hornbuckle (2010) found PCBs in 15 out of the 33 analyzed pigment samples and total PCB levels in samples with detections ranged from 2 to 198.3 ppb. PCB detections were more frequently associated with organic pigments (as opposed to inorganic pigments such as titanium oxide, iron oxide, raw umber, or carbon black [Hu and Hornbuckle, 2010]). Across all pigment samples, the congeners with more than a 40% detection frequency, ordered by detection frequency from higher to lower were: PCBs 11, 8, 6, 4, 12/13, 1, and 2 (Table A3.5). The most frequently detected congener in the US pigments (Hu and Hornbuckle, 2010) was PCB 11, which accounted for approximately 7.3% on average (12.1%, if detected) of the total PCB mass (range of 0-62%, median of 1.07%; median of 5.6%, if detected).

PCB levels measured in pigments from Japan, China, and Europe appeared to be higher relative to those in the US study and spanned several orders of magnitude (3-919,000 ppb; Table A3.4). In 2012, the Japanese Ministry of Environment Trade and Industry (METI) surveyed over 500 pigment samples and identified seven pigments with total PCB concentrations greater than 50 ppm (50,000 ppb [METI *et al*., 2012]). Two of these seven pigments were used in painting materials, while the others were used in pens, pencils, fabric colorants, and printing ink (METI, 2013). METI subsequently prohibited the manufacturing, import, and shipment of these pigments (METI, 2013).

PCBs were also found in pigments from Canada but at levels that are comparable to that of the US study. As reported in Environment Canada and Health Canada (2014), levels of PCBs in diarrylide yellow pigments from Canada were 20-9,000 ppb, but no congener-level information was available.

Table A3.4 Levels of PCBs in Pigments from the US and Other Countries

Country Where Pigments Were Purchased	Number of Samples with Detection/Total	PCB 11 Concentration (ppb)	Total PCB Concentration (ppb)	Reference
US	15/33	<MDL-16.38	<MDL-198.3	Hu and Hornbuckle (2010)
Japan	35/46	<MDL-14,000	<MDL-740,000	Anezaki and Nakano (2014)
Japan	15/15	3-25	17-6,500	Anezaki and Nakano (2013)
Japan, Italy, UK, France, The Netherlands	31/31	<MDL-2.7	1.9-29,000	Anezaki *et al*. (2014)
China	14/14	41.7-918,000	50.7-919,000[a]	Shang *et al*. (2014)

Notes:
MDL = Method Detection Limit; PCB = Polychlorinated Biphenyl; ppb = Parts Per Billion; UK = United Kingdom.
(a) Only 20 PCB congeners were measured.

Table A3.5 Detection Frequency of Congeners in Paint Pigments

Congener	Detection Frequency
PCB 11	87%
PCB 8	80%
PCB 6	73%
PCB 4	67%
PCB 12/13	53%
PCB 1	40%
PCB 2	40%

Notes:
PCB = Polychlorinated Biphenyl.
Source: Hu and Hornbuckle (2010).

A3.3.2 Byproduct PCBs in Consumer Products

PCBs in consumer products such as printed paper, cardboard packaging, plastic bags, and fabric materials were measured by Rodenburg *et al*. (2010) and Guo *et al*. (2014). Both studies focused on PCB 11, and the results of these studies are summarized in Table A3.6 and discussed in more detail in the following paragraphs.

Table A3.6 PCB 11 Concentration in Products Containing Paint Pigments

Study	Materials	PCB 11 (ppb)
Rodenburg *et al*. (2010)	Paper products (US, N = 16): Manilla envelopes, printed and unprinted cardboard, plain white paper	ND-6.6
	Yellow plastic bags (US, N = 2)	3.4-38
Guo *et al*. (2014)	Printed materials (non-US, N = 28)	1.5-86
	Printed fabric materials (US,[a] N = 6)	2.5-79
	Dyed fabric materials (US,[a] N = 10)	0.27-3.1

Notes:
ND= Not Detected.
Source: Hu and Hornbuckle (2010).
(a) Purchased in the US, but produced outside the US.

In the Rodenburg *et al*. (2010) study, which focused on products purchased in the US, PCB 11 was detected in black and white printed newspaper, brown unprinted cardboard, color newspaper and magazines, as well as in various yellow products – *e.g*., cereal boxes, plastic bags, and sticky notes. This congener was not detected in plain white copy paper and was below the method detection limit of 0.25 ppb in two manila envelope samples and one sample of yellow sticky notes. The highest concentration of PCB 11 (38 ppb) was measured in a yellow plastic bag. All other products had concentrations between 0.45 and 6.6 ppb. The detection of PCB 11 was mostly attributed to pigments, as PCB 11 was the most dominant congener detected in the colored products.[10]

The Guo *et al*. (2014) study expanded the list of products to include printed and non-printed fabric materials, as well as paper products from other countries. The printed materials from other countries had PCB 11 concentrations between 1.5-86 ppb, and included paper from magazines, advertisements, maps, postcards, and brochures. The authors also measured PCB 11 concentrations in textile clothing and found higher levels of PCB 11 in fabrics with printed designs (2.5-79 ppb) relative to fabrics without such designs (0.27-3.1 ppb). The presence of PCB 11 in printed fabric was attributed to the use of pigments in these designs. The presence of PCB 11 in the dyed (*i.e*., non-printed) fabrics was not attributed to the dye, as dichlorobenzidine-base dyes such as diarylide yellow are no longer used in clothing due to the potential leaching of DCB. The authors hypothesized that the low levels of PCB 11 measured in the dyed fabric were instead coming from cross-contamination during the production of the cloth or the garment.

A3.3.3 Byproduct PCBs in Washington State and City of Spokane Products

The Washington State Department of Ecology (WA Ecology) performed two studies to evaluate the presence of PCBs in a variety of consumer products (WA Ecology, 2014a, 2016). In the first study, WA Ecology (2014a) characterized the levels of only a few byproduct PCB congeners (*i.e*., PCBs 11, 206, 208, and 209) in packaging, paper products, paints, colorants, caulks,[11] printer inks, and food samples (although full congener data from this study was later made available on the WA Ecology website; WA Ecology, 2019). PCB 11 was detected in 66% of the samples, and its concentration ranged from 1 to 45 ppb. PCB 209 was only detected in 10% of the samples, and PCBs 206 and 208 were detected only in phthalocyanine green-based colorant.

In the second study, WA Ecology (2016) expanded the list of products to include caulks, children's products, clothing, comic books, containers/boxes, cosmetics, labels, office products, paints/colorants/dyes, pesticides, lawn care products, plastics, printed material, and road paints. A total of 216 samples were collected from 201 products. The total PCBs detected in each product category are summarized in Table A3.7. PCBs were detected in 89% of the samples, and the highest concentrations (1,000-2,320 ppb) were found in yellow sidewalk chalk, cereal packaging, and "yellow foam office product."[12] The majority of the products had either a single or 2-5 PCB congener profile. PCBs 11, 209, and 12/13 accounted for the majority of single congener detects. The most frequently detected congeners were PCBs 11, 52, 61/70/74/76, and 31; these detections were attributed to the presence of dyes and pigments in the products. The study also noted that some products contained a broad range of congeners (from PCB 8 to PCB 197), but that the pattern did not resemble Aroclors.

[10] The authors also constructed loadings of PCBs for the New York/New Jersey Harbor, as well as the Delaware River, which provided evidence that (1) PCB 11 was not a likely product of reductive dechlorination, and (2) its presence was widespread even in watersheds without impacts from the discharges of pigment manufacturers. The authors concluded that wastewater plant effluents and stormwater effluents were the main conveyance of PCB 11 to the Delaware River, which originated from consumer goods, and that PCB 11 could be an obstacle for implementing PCB TMDLs in other US watersheds.

[11] Caulks were investigated in the City of Spokane study because they are known to contain polychlorinated paraffins, and byproduct PCBs are associated with production of polychlorinated paraffins (SWWM, 2015).

[12] WA Ecology (2016) also refers to this product as "Yellow Glitter Foam Sheet," which appears to be an arts and crafts product with glitter and a peel-and-stick back.

Table A3.7 Summary of Byproduct PCB Congeners Measured in New Products

Category	Number of Samples	No. < MRL	<1	1 to <10	10 to <100	≥100	Min.	Max.	Avg.
			ppb						
Caulk[a]	8	7	0	0	0	1	0.04	390.0	N/A
Children's Products	14	2	4	5	2	1	<0.08	1,060.0	79.6
Clothing	5	0	0	3	2	0	1.3	16.6	8.5
Comic Books	10	0	0	10	0	0	1.1	5.0	2.7
Containers/Boxes	31	0	0	4	24	3	2.7	226.0	47.5
Cosmetics/Body Care	11	0	8	3	0	0	0.1	7.8	1.4
Labels	35	0	0	13	21	1	3.8	138.0	17.2
Misc.[a]	2	0	2	0	0	0	0.05	0.2	N/A
Office	17	4	2	6	3	2	0.2	2310.0	108.1
Paints/Colorants/Dyes	24	4	5	9	5	1	0.06	339.0	22.0
Lawn & Road Care	19	4	10	5	0	0	0.03	7.0	1.1
Plastics	17	1	3	9	3	1	2	2,320.00	144.4
Printed Materials/Newsprint	12	0	0	8	4	0	2.4	53.5	16.5
Road Paints	11	1	3	5	2	0	<0.08	102.0	14.9
Total Count	**216**	**23**	**37**	**80**	**66**	**10**			
Total Percentage	**99.9**	**10.6**	**17.1**	**37**	**30.6**	**4.6**			

Notes:
MRL = Method Reporting Limit; ppb = Parts Per Billion.
Source: WA Ecology (2016).
(a) For those categories for which only one sample contained PCBs, the "Min." and "Max." in this instance, are the minimum and maximum levels for that single sample. No "Avg." can be calculated and therefore is assigned "N/A" for "Not Applicable."

The City of Spokane also investigated PCBs in municipal products that are commonly used in road and facility maintenance, such as road paint, asphalt sealers, pesticides, and deicers (SWWM, 2015). The products were chosen based on potential associations with byproduct PCB-containing chemicals, such as pigments and chlorinated paraffins (Table A3.8), as well as on the potential for stormwater discharge. Products identified to have a high potential for stormwater discharge included motor oils and petroleum products. Samples of some of these products were also sent to WA Ecology for analysis and included in the WA Ecology (2016) study.

Table A3.8 Examples of Chemicals Associated with Byproduct PCB Production

Chemical	Associated Products
Ethylenediamine	Surfactants, fungicides, fuel additives, ethylenediaminetetraacetic acid (EDTA), hair car products, soaps
Ethylene dichloride	Polyvinyl chloride (PVC), solvents
Phenylchlorosilanes	Silicones: lubricants, adhesives, coatins, hoses
Chlorinated benzidines	Pigments
Chlorinated paraffins	Flame retardants in plastics, paints, adhesives, sealants, and caulks
Glycerol/glycerin (synthesized by epichlorohydrine)	Toothpaste, numerous personal care products, antifreeze, resins

Notes:
PCB = Polychlorinated Biphenyl.
Source: SWWM (2015).

In order of decreasing detection frequency, PCBs 52/69, 11, and 28 were the most frequently detected congeners in the 41 municipal products analyzed in the Spokane study (SWWM, 2015). PCBs were also identified in pesticides (*e.g.*, Portfolio 4F had total PCBs of 6.89 ppb, which was made up of mostly PCB 64/72) and in magnesium chloride (*e.g.*, DustGuard had total PCBs of 3.574 ppb, which was made up of mostly PCBs 50 and 53), but the sources of the detected congeners were not clear. The congeners detected in more than half of the sampled products were PCBs 11, 8, 28, 52/69, 95, 101, and 153.

The highest total PCB concentration in the Spokane municipal products study (SWWM, 2015) was measured in hydroseed (2,509 ppb). In a follow-up study, the Spokane River Regional Toxics Task Force (referred to herein as the "Task Force"; SRRTTF, 2015) further evaluated the presence of PCBs in hydroseed products from three different manufacturers, including the one represented in the Spokane study. The Task Force study found concentrations in the hydroseed products that were much lower than those measured by SWWM (2015). Only one out of the four products investigated had concentrations above the laboratory reporting limit. The measured total PCBs in this product was 4.65 ppb and consisted entirely of PCB 29. Other congeners were detected when the individual ingredients were tested separately, such as PCB 209 in the dye (0.6-2.1 ppb), PCB 15 in the base material (0.513 ppb in one product), and a broad mixture of PCBs resembling Aroclor 1242 in the tackifier (5.56 ppb quantified as Aroclor 1242).

From the studies mentioned above, two studies specifically measured the concentrations of PCBs in road paint and striping[13] (SWWM, 2015; WA Ecology, 2016), and according to SWWM (2015), both studies measured the same samples. Table A3.9 shows the results of these two studies side by side. The average of all the measurements in Table A3.9 is 12.3 ppb and the range is 0.28-102 ppb. Consistent with evidence from literature studies of paint pigments, the congener profile of these paints, plotted using the WA Ecology (2016) measurements, are dissimilar to that of PCB Aroclors (Chart A3.6). The yellow road paint is dominated by PCBs 11, 35, and 77, while white paint is dominated by PCB 209. As discussed in the following sections, PCB 77 is also present in Aroclors at levels up to 0.52%, but the presence of PCB 77 in the yellow paint is not accompanied by the other Aroclor congeners.

[13] Road striping is a thermoadhesive material used to mark roads in order to create elevation and recession patterns.

Table A3.9 Comparison of Total PCBs Measured in Road Paint and Striping by WA Ecology and the City of Spokane

Sample	Total PCBs as Reported in WA Ecology (2016)	Total PCBs as Reported in SWWM (2015)
Yellow Road Striping	5.45 ppb	10.78 ppb
White Road Striping	2.45 ppb	3.33 ppb
Yellow Road Paint	Product 1: 102 ppb Product 2: 1.44 ppb	Product A: 0.73, 2.69 ppb (2 replicates) Dried Product A: 0.565 ppb Product B: 64.88 ppb
White Road Paint	Product 1: 0.58 ppb Product 2: 0.3 ppb	Product A: 0.4, 0.41 ppb (2 replicates) Dried Product A: 0.38 ppb Product B: 0.28 ppb

Notes:
PCB = Polychlorinated Biphenyl; ppb = Parts Per Billion.

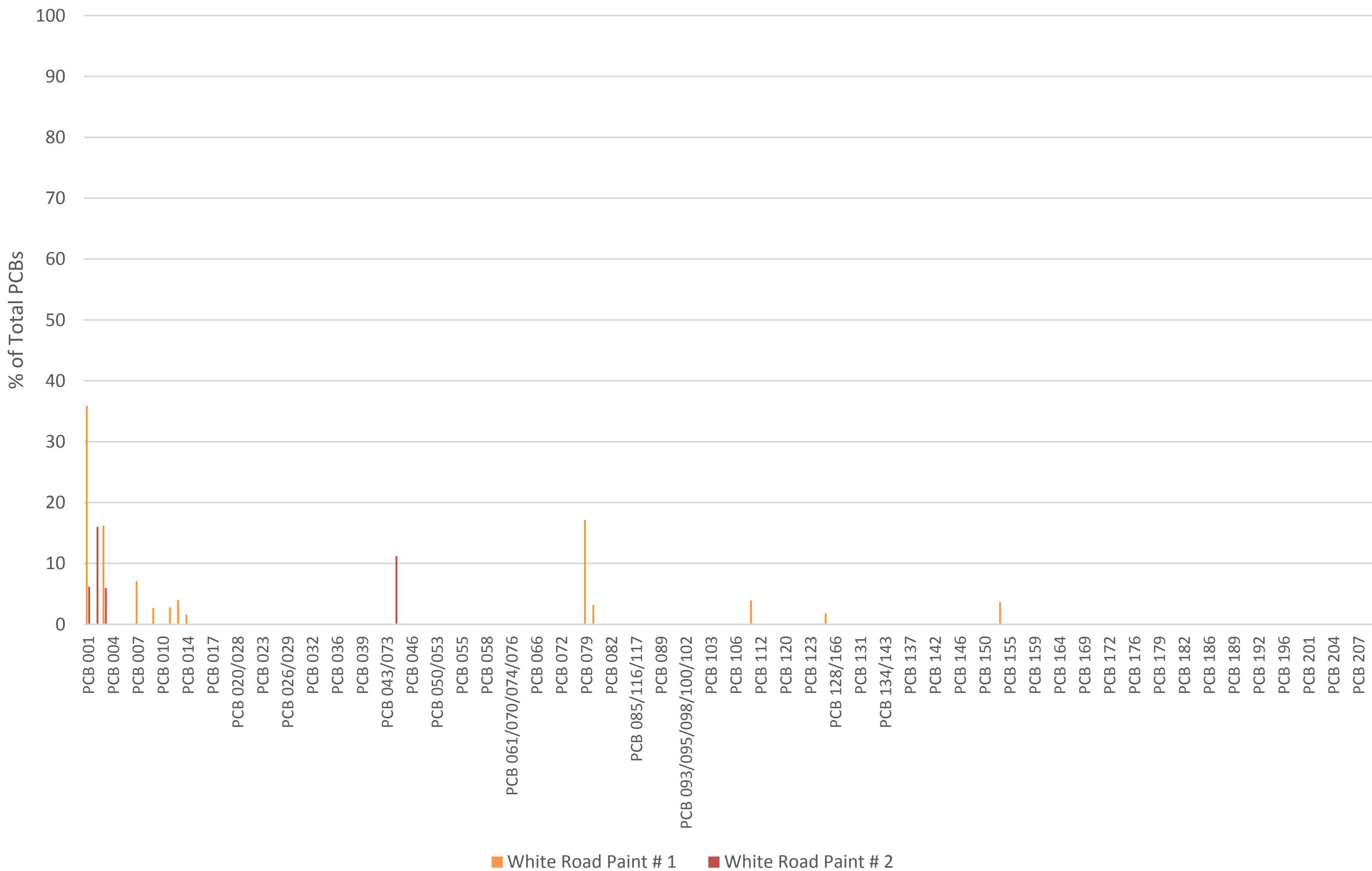


Chart A3.6 PCB Congener Distribution Measured in White and Yellow Road Paint. PCB = Polychlorinated Biphenyl.

References

Anezaki, K; Kannan, N; Nakano, T. 2014. "Polychlorinated biphenyl contamination of paints containing polycyclic- and Naphthol AS-type pigments." *Environ. Sci. Pollut. Res. Int.* 22(19):14478-14488. doi: 10.1007/s11356-014-2985-6.

Anezaki, K; Nakano, T. 2013. "Polychlorinated biphenyl contamination in polycyclic-type pigments and silicone-based glues." *Organohalogen Compounds* 75:517-520.

Anezaki, K; Nakano, T. 2014. "Concentration levels and congener profiles of polychlorinated biphenyls, pentachlorobenzene, and hexachlorobenzene in commercial pigments." *Environ. Sci. Pollut. Res. Int.* 21(2):998-1009. doi: 10.1007/s11356-013-1977-2.

Anezaki, K; Nakano, T. 2015. "Unintentional PCB in chlorophenylsilanes as a source of contamination in environmental samples." *J. Hazard. Mater.* 287:111-117. doi: 10.1016/j.jhazmat.2015.01.026.

Ballschmiter, K; Niemczyk, R; Schafer, W; Zoller, W. 1987. "Isomer-specific identification of polychlorinated benzenes (PCBz) and -biphenyls (PCB) in effluents of Municipal waste incineration." *Fresenius Z. Anal. Chem.* 328(7):583-587. doi: 10.1007/BF00468973.

Buchta, RC; Wyles, HF; Hensler, CJ; Van Lenten, FJ; Westerberg, RB; Williams, LA. 1985. "Determination of polychlorinated biphenyls in copper phthalocyanine pigments." *J. Chromatogr. A* 325:456-461. doi: 10.1016/S0021-9673(00)96057-6.

Callahan, MAA; Hammerstrom, KA; Schweer, G. 1983. "Present PCB uses and their potential for release to the environment." In *Proceedings, PCB-Seminar held September 28-30, Scheveningen, The Hague, The Netherlands*. (Eds.: Barros, MC; Koeneman, H; Visser, R), Netherlands, Ministry of Housing, Physical Planning and Environment. p152-172.

Cargill, D. [Washington State Dept. of Ecology (WA Ecology)]. 2014. "PCBs from Building Materials and Other Sources in the Urban Environment." Presented at the 2014 Salish Sea Ecosystem Conference, Seattle, WA. 20p., April 30.

Christie, RM. [Heriot-Watt University]. 2013. "Alternatives for elimination of polychlorinated biphenyls (PCBs) in pigments used for printing inks and architectural paints." Presented at the National Pollution Prevention Roundtable "Advancing Green Chemistry: PCBs in Pigments" Webinar. 21p., June 27.

Christie, R. 2016. "Inadvertent PCB formation from a pigment chemistry perspective (GCE307)." Presented at the 20th Annual ACS Green Chemistry & Engineering Conference. 22p., June 16.

Cristol, SJ. [University of Colorado]. 1983. "Organic Chemical Processes Leading to Generation of Incidental Polychlorinated Biphenyls." Report to US EPA, Office of Toxic Substances. 6p., February 10.

Ctistis, G; Schon, P; Bakker, W; Luthe, G. 2016. "PCDDs, PCDFs, and PCBs co-occurrence in TiO2 nanoparticles." *Environ. Sci. Pollut. Res.* 23(5):4837-4843. doi: 10.1007/s11356-015-5628-7.

Cui, S; Qi, H; Liu, LY; Song, WW; Ma, WL; Jia, HL; Ding, YS; Li, YF. 2013. "Emission of unintentionally produced polychlorinated biphenyls (UP-PCBs) in China: Has this become the major source of PCBs in Chinese air?" *Atmos. Environ.* 67:73-79. doi: 10.1016/j.atmosenv.2012.10.028.

Dong, S; Wu, J; Liu, G; Zhang, B; Zheng, M. 2011. "Unintentionally produced dioxin-like polychlorinated biphenyls during cooking." *Food Control* 22(11):1797-1802. doi: 10.1016/j.foodcont. 2011.04.022.

Du, S; Belton, TJ; Rodenburg, LA. 2008. "Source apportionment of polychlorinated biphenyls in the tidal Delaware River." *Environ. Sci. Technol.* 42(11):4044-4051. doi: 10.1021/es703047a.

Environment Canada; Health Canada. 2014. "Screening Assessment: Aromatic Azo and Benzidine-based Substance Grouping; Certain Diarylide Yellow Pigments." 116p., October.

Erickson, MD; Stanley, JS; Turman, JK; Going, JE; Redford, DP; Heggem, DT. 1988. "Determination of byproduct polychlorobiphenyls in commercial products and wastes by high-resolution gas chromatography/electron impact mass spectrometry." *Environ. Sci. Technol.* 22(1):71-76. doi: 10.1021/ es00166a007.

Gazquez, MJ; Bolivar, JP; Garcia-Tenorio, R; Vaca, F. 2014. "A review of the production cycle of titanium dioxide pigment." *Mater. Sci. Appl.* 5:441-458. doi: 10.4236/msa.2014.57048.

Guo, J; Capozzi, SL; Kraeutler, TM; Rodenburg, LA. 2014. "Global distribution and local impacts of inadvertently generated polychlorinated biphenyls in pigments." *Environ. Sci. Technol.* 48:8573-8580. doi: 10.1021/es502291b.

Herbst, W; Hunger, K; Wilker, G; Ohleier, H; Winter, R. 2004. "Azo Pigments." In *Industrial Organic Pigments: Production, Properties, Applications (Third Edition)*. Wiley-VCH Verlag GmbH & Co. KGaA, Weinheim, Germany. p183-419.

Hu, D; Hornbuckle, KC. 2010. "Inadvertent polychlorinated biphenyls in commercial paint pigments." *Environ. Sci. Technol.* 44(8):2822-2827. doi: 10.1021/es902413k.

Hu, D; Martinez, A; Hornbuckle, KC. 2008. "Discovery of non-Aroclor PCB (3,3'-dichlorobiphenyl) in Chicago air." *Environ. Sci. Technol.* 42(21):7873-7877.

Huang, J; Gao, J; Yu, G; Yamazaki, N; Deng, S; Wang, B; Weber, R. 2015. "Unintentional formed PCDDs, PCDFs, and DL-PCBs as impurities in Chinese pentachloronitrobenzene products." *Environ. Sci. Pollut. Res.* 22(19):14462-14470. doi: 10.1007/s11356-014-3507-2.

Ishikawa, Y; Noma, Y; Yamamoto, T; Mori, Y; Sakai, SI. 2007. "PCB decomposition and formation in thermal treatment plant equipment." *Chemosphere* 67(7):1383-1393. doi: 10.1016/j.chemosphere.2006. 10.022.

Japan, Ministry of Economy, Trade and Industry (METI); Japan, Ministry of Health, Labour and Welfare (MHLW); Japan, Ministry of the Environment (MOE). 2012. "Summarized Results of the Second Investigation into the Presence of Polychlorinated Biphenyls (PCBs) as By-products in Organic Pigments (Joint Press Release)." August 30. Accessed at https://web.archive.org/web/20130106183204/ http://www.meti.go.jp/english/press/2012/0830_01.html.

Japan, Ministry of Economy, Trade and Industry (METI). 2013. "Administrative Guidance on Manufacture, Import, etc. of Organic Pigments that can Unintentionally Contain Polychlorinated Biphenyls (Sixth Report) (Press Release)." March 22. Accessed at https://web.archive.org/web/20130409004204/http://www.meti.go.jp/english/press/2013/0322_03.html.

Jiang, X; Liu, G; Wang, M; Zheng, M. 2015. "Formation of polychlorinated biphenyls on secondary copper production fly ash: Mechanistic aspects and correlation to other persistent organic pollutants." *Sci. Rep.* 5:13903. doi: 10.1038/srep13903.

Kim, KS; Hirai, Y; Kato, M; Urano, K; Masunaga, S. 2004. "Detailed PCB congener patterns in incinerator flue gas and commercial PCB formulations (Kanechlor)." *Chemosphere* 55(4):539-553. doi: 10.1016/j.chemosphere.2003.11.056.

Kim, SC; Hwang, SR; Kim, KH; Lee, JH; Choi, JW. 2005. "Emission characteristics of coplanar PCBs in stationary thermal sources." *Organohalogen Compounds* 67:2008-2010.

Law, RJ. 1995. "3,3'-dichlorobenzidine: A candidate for inclusion in marine monitoring programmes?" *Chemosphere* 30(9):1791-1797. doi: 10.1016/0045-6535(95)00063-E.

Leidos. 2016. Technical Memorandum: Potential for PCB Contamination from Sampling Equipment Tubing Materials. 6p., November 23.

Li, S; Liu, G; Zheng, M; Liu, W; Li, J; Wang, M; Li, C; Chen, Y. 2017. "Unintentional production of persistent chlorinated and brominated organic pollutants during iron ore sintering processes." *J. Hazard. Mater.* 331:63-70. doi: 10.1016/j.jhazmat.2017.02.027.

Litten, S; Fowler, B; Luszniak, D. 2002. "Identification of a novel PCB source through analysis of 209 PCB congeners by US EPA modified method 1668." *Chemosphere* 46(9-10):1457-1459. doi: 10.1016/S0045-6535(01)00253-3.

Liu, W; Li, H; Tao, F; Li, S; Tian, Z; Xie, H. 2013a. "Formation and contamination of PCDD/Fs, PCBs, PeCBz, HxCBz and polychlorophenols in the production of 2,4-D products." *Chemosphere* 92(3):304-308. doi: 10.1016/j.chemosphere.2013.03.031.

Liu, G; Zheng, M; Cai, M; Nie, Z; Zhang, B; Liu, W; Du, B; Dong, S; Hu, J; Xiao, K. 2013b. "Atmospheric emission of polychlorinated biphenyls from multiple industrial thermal processes." *Chemosphere* 90(9):2453-2460. doi: 10.1016/j.chemosphere.2012.11.008.

Liu, W; Tao, F; Zhang, W; Li, S; Zhang, M. 2012. "Contamination and emission factors of PCDD/Fs, unintentional PCBs, HxCBz, PeCBz and polychlorophenols in chloranil in China." *Chemosphere* 86(3):248-251. doi: 10.1016/j.chemosphere.2011.09.034.

Liu, W; Zheng, M; Wang, D; Xing, Y; Zhao, X; Ma, X; Qian, Y. 2004. "Formation of PCDD/Fs and PCBs in the process of production of 1,4-dichlorobenzene." *Chemosphere* 57(10):1317-1323. doi: 10.1016/j.chemosphere.2004.09.024.

Masunaga, S; Takasuga, T; Nakanishi, J. 2001. "Dioxin and dioxin-like PCB impurities in some Japanese agrochemical formulations." *Chemosphere* 44(4):873-875. doi: 10.1016/S0045-6535(00)00310-6.

Munoz, G. 2007. "Processes that inadvertently produce PCBs." In *Optimizing Contaminant Trackdown: Focusing on Wastewater Treatment Plants and Related Systems. A Compendium for Practitioners of Contaminant Trackdown Efforts*. New York Academy of Sciences, New York, NY, p208-223.

Ontario Ministry of the Environment. 1975. "The Aqueous Chlorination of Biphenyl - Possibilities for PCB Production in Sewage Treatment Plants." Laboratory Services Branch, OTC Report 7901. 28p.

Panero, M; Boehme, S; Munoz, G. 2005. "Pollution Prevention and Management Strategies for Polychlorinated Biphenyls Aromatic Hydrocarbons in the New York/New Jersey Harbor." 110p., February.

Perdih, A; Jan, J. 1994. "Formation of polychlorobiphenyls in silicone rubber." *Chemosphere* 28(12):2197-2202. doi: 10.1016/0045-6535(94)90187-2.

Pizzini, S; Sbicego, C; Corami, F; Grotti, M; Magi, E; Bonato, T; Cozzi, G; Barbante, C; Piazza, R. 2017. "3,3'-dichlorobiphenyl (non-Aroclor PCB-11) as a marker of non-legacy PCB contamination in marine species: Comparison between Antarctic and Mediterranean bivalves." *Chemosphere* 175:28-35. doi: 10.1016/j.chemosphere.2017.02.023.

Praipipat, P; Rodenburg, LA; Cavallo, GJ. 2013. "Source apportionment of polychlorinated biphenyls in the sediments of the Delaware River." *Environ. Sci. Technol.* 47(9):4277-4283. doi: 10.1021/es400375e.

Rieper, W. [Hoechst Aktiengesellschaft]. 1993. "Preparation of Azo Pigments with Low PCB Content by Coupling in the Presence of Olefins." US Patent 5,243,032. 8p., September 7.

Rodenburg, LA. [Rutgers University]. 2012. "Inadvertent PCB production and its impact on water quality." Presented at the ECOS Annual Meeting, Colorado Springs, CO. 11p., August 28. Accessed at http://srrttf.org/wp-content/uploads/2012/08/Lisa-Rodenburg-Slideshow.pdf.

Rodenburg, L. 2016. "PCB contamination from silicone rubber." August 24. Accessed at http://supersewers.blogspot.com/2016/08/pcb-contamination-from-silicone-rubber.html.

Rodenburg, LA; Guo, J; Du, S; Cavallo, GJ. 2010. "Evidence for unique and ubiquitous environmental sources of 3,3'-dichlorobiphenyl (PCB 11)." *Environ. Sci. Technol.* 44(8):2816-2821. doi: 10.1021/es901155h.

Rodenburg, L; Guo, J; Christie, R. 2015. "Polychlorinated biphenyls in pigments: Inadvertent production and environmental significance." *Coloration Technol.* 131(5):353-369. doi: 10.1111/cote.12167.

Sakai, S; Hiraoka, M; Takeda, N; Shiozaki, K. 1994. "Formation and emission of non-ortho CBs and mono-ortho CBs in municipal waste incineration." *Chemosphere* 29(9-11):1979-1986. doi: 10.1016/0045-6535(94)90364-6.

Shang, H; Li, Y; Wang, T; Wang, P; Zhang, H; Zhang, Q; Jiang, G. 2014. "The presence of polychlorinated biphenyls in yellow pigment products in China with emphasis on 3,3'-dichlorobiphenyl (PCB 11)." *Chemosphere* 98:44-50. doi: 10.1016/j.chemosphere.2013.09.075.

Sistovaris, N; Donges, U; Dudek, B. 1990. "Determination of traces of polychlorinated biphenyls in pigments." *J. High Resolut. Chromatogr.* 13(8):547-549. doi: 10.1002/jhrc.1240130804.

Spokane River Regional Toxics Task Force (SRRTTF). 2015. "Hydroseed Pilot Project Summary Report." 54p., July 31.

Spokane, Washington, Wastewater Management Dept. (SWWM). 2015. "PCBs in Municipal Products (Revised)." 45p., July 21.

Takasuga, T; Inoue, T; Ohi, E; Umetsu, N; Ireland, P; Takeda, N. 1994. "Characterization of PCBs formed during thermal processes." *Organohalogen Compounds* 19:173-176.

Takasuga, T; Nakano, T; Shibata, Y. 2012. "Unintentional POPs (PCBs, PCBz, PCNs) contamination in articles containing chlorinated paraffins and related impacted chlorinated paraffin products." *Organohalogen Compounds* 74:1437-1441.

Takasuga, T; Nakano, T; Shibata, Y. 2014. "Identification of PCB congeners by unintentional formation." Organohalogen Compounds 76:1430-1433.

Tian, B; Huang, J; Wang, B; Deng, S; Yu, G. 2012. "Emission characterization of unintentionally produced persistent organic pollutants from iron ore sintering process in China." *Chemosphere* 89(4):409-415. doi: 10.1016/j.chemosphere.2012.05.069.

US EPA. 1979a. "Polychlorinated biphenyls (PCBs); Manufacturing, processing, distribution in commerce, and use prohibitions (Final rule)." *Fed. Reg.* 44(106):31514-31558. 40 CFR 761. May 31.

US EPA. 1979b. "Polychlorinated biphenyls (PCBs); Proposed rulemaking for PCB manufacturing exemptions (Proposed PCB exemption rule; Notice of informal hearing)." *Fed. Reg.* 44(106):31564-31567. May 31.

US EPA. 1982. "Polychlorinated biphenyls (PCBs); Manufacturing, processing, distribution and use in closed and controlled waste manufacturing processes (Proposed)." *Fed. Reg.* 47:24976-24989. June 8.

US EPA. 1983. "Polychlorinated biphenyls; Exclusions, exemptions and use authorizations (Proposed rule)." *Fed. Reg.* 48(237):55076-55098. 40 CFR 761. December 8.

US EPA. 1984. "Toxic Substances Control Act; Polychlorinated biphenyls (PCBs) manufacturing, processing, distribution in commerce, and use prohibitions; Exclusions, exemptions and use authorizations (Final rule)." *Fed. Reg.* 49(133):28172-29066. 40 CFR 761. July 10.

US EPA. 2008. "TSCA Section 13 Import Compliance Checklist." Office of Pollution Prevention and Toxics. EPA 740-B-08-001. 14p., April.

US EPA. 2011. "PCB TMDL Handbook." Office of Wetlands, Oceans and Watersheds. EPA 841-R-11-006. 33p., December.

Uyeta, M; Taue, S; Chikazawa, K. 1976. "Polychlorinated biphenyls in the phthalocyanine pigments." *Bull. Environ. Contam. Toxicol.* 16(4):417-421. doi: 10.1007/BF01686155.

Vorkamp, K. 2016. "An overlooked environmental issue? A review of the inadvertent formation of PCB-11 and other PCB congeners and their occurrence in consumer products and in the environment." *Sci. Total Environ.* 541:1463-1476. doi: 10.1016/j.scitotenv.2015.10.019.

Washington State Dept. of Ecology (WA Ecology). 2014a. "Polychlorinated Biphenyls (PCBs) in General Consumer Products." Publication No. 14-04-035. 64p., June.

Washington State Dept. of Ecology (WA Ecology). 2014b. "Alternatives for elimination of polychlorinated biphenyls (PCBs) in pigments used for printing inks and architectural paints." Publication no. 14-07-005. 39p., February.

Washington State Dept. of Ecology (WA Ecology). 2016. "Polychlorinated Biphenyls in Consumer Products." Publication no. 16-04-014. 61p., November.

Washington State Dept. of Ecology (WA Ecology). 2019. "EIM Search: Environmental Information Management System." Accessed at https://apps.ecology.wa.gov/eim/search/Default.aspx.

Tables

Table A3.1 Byproduct PCB Congeners in Organic and Inorganic Pigments[a]

Pigment Types	Colors	Homologs (# of Chlorine) 1	2	3	4	5	6	7	8	9	10	Detected PCB Congeners	References
Titanium dioxide *via* chloride process	White			■	■				■	■	■	18/30, 44/47/65, 52, 196, 198/199, 203, 206, 207, 208, 209[b]	WA Ecology (2014a)
										■	■	206, 208, 209[c]	SWWM (2015)
		■	■		■	■	■				■	1, 2, 3, 7, 9, 11, 12/13, 14, 44/47/65, 79, 80, 111, 127, 153/168, 209[b]	WA Ecology (2016)
						■	■	■				101, 138, 153, 180, 105, 118, 156, 157, 167, 189	Ctistis *et al*. (2016)
Azo-type from chlorinated benzidines (includes diarrylide yellow)	Yellow, orange, red	■	■	■	■	■	■					2, 11, 35, 52,77, 101, 153	Anezaki and Nakano (2014)
		■	■		■	■						1, 2, 3, 4, 6, 8, 11, 12/13, 52, 90/100/113, 95	Hu and Hornbuckle (2010)
			■	■	■	■	■	■			■	11, 28, 52, 77, 81, 101, 105, 114, 118, 123, 126, 138, 153, 156, 157, 167, 169, 180, 189, 209[d]	Shang *et al*.(2014)
			■		■							11, 52	Sistovaris *et al*. (1990)
Phthalocyanine	Blue, green					■	■				■	Penta and hexa-chlorinated congeners, 209	Uyeta *et al*. (1976)
						■	■	■			■	Penta, hexa, and septa-chlorinated congeners, 209	Buchta *et al*. (1985)
		■	■	■	■	■	■	■		■	■	1, 2, 3, 4, 5, 6, 7, 8, 9, 11, 12/13, 15, 18/30, 20/28, 21/33, 31, 40/41/71, 52, 56, 61/70/74/76, 66, 77, 86/87/97/109/119/125, 90/100/113, 95, 106, 108, 110/115, 114, 118, 123, 129/138/163, 132, 135/151, 142, 146, 147/149, 153/168, 160, 161, 187, 206, 207, 208, 209	Hu and Hornbuckle (2010)
		■	■			■			■	■	■	2, 4, 5/8, 6, 11, 12/13, 15, 93/95/98, 101, 194, 196, 198, 199, 202, 203, 205, 206, 207, 208, 209	Anezaki and Nakano (2014)
Dioxazine and diketopyrrolopyrrole pigments	Red, green, violet	■	■	■	■							1, 2, 3, 4, 5, 6, 7, 8, 9, 11, 12, 13, 15, 16, 20/33, 40, 56, 77	Anezaki and Nakano (2014)
		■	■	■	■							1, 2, 3, 4, 5, 6, 7, 8, 9, 11, 10, 12, 13, 15, 16, 20/33, 31, 35, 40, 56, 77	Anezaki and Nakano (2013)
		■	■	■	■							1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 15, 16, 18, 20/33, 26, 31, 35, 40, 56, 77	Anezaki *et al*. (2014)
			■									–	Sistovaris *et al*. (1990)

Pigment Types	Colors	Homologs (# of Chlorine)										Detected PCB Congeners	References
		1	2	3	4	5	6	7	8	9	10		
Azo-type (Napthol-AS from di- and tri-chloroanilines)	Red											4, 6, 8, 9, 13, 15, 17, 18, 20/33, 25, 26, 28, 30, 31, 49, 52, 70, 84, 86, 92, 93/95/98, 101, 153	Anezaki *et al*. (2014)
												1, 2, 3, 5, 6, 9, 11, 12, 17, 18, 20/33, 22, 23, 24, 25, 26, 28, 29, 31, 35, 37, 45, 48, 52, 56, 59, 63, 64, 67, 70, 74, 77, 83, 84, 90, 91, 92, 95, 97, 99, 101, 102, 109, 110, 118, 120, 135, 136, 146, 149, 153, 172, 174, 176, 178, 179, 180, 183, 187, 194, 199, 203	Anezaki *et al*. (2014)
												52	Sistovaris *et al*. (1990)
Unspecified pigment production	Various											11, 35, 77, 126	Litten *et al*. (2002)
												11, 36	Law (1995)
												1, 2, 3, 4, 5, 6, 7, 8, 9, 11, 12/13, 15, 16, 18/30, 20/28, 21/33, 31, 40/41/71, 52, 56, 61/70/74/76, 66, 77, 78, 86/87/97/109/119/125, 90/101/113, 95, 106, 108, 110/115, 114, 118, 123, 129/138/163, 132, 135/151, 142, 146, 147/149, 153/168, 160, 161, 187, 206, 207, 208, 209	Hu and Hornbuckle (2010)

Notes:
PCB = Polychlorinated Biphenyl.
(a) Detected in organic and inorganic pigments or linked to pigment production.
(b) From raw data associated with the report and downloaded from the WA Ecology website (WA Ecology, 2019).
(c) Full congener not available in the report.
(d) Only these congeners were measured.

Table A3.2 Byproduct PCB Congeners Related to Non-pigment Processes

Process/Chemical Substance	Product/Industry	Matrix Measured	Homologs (# of Chlorine) 1	2	3	4	5	6	7	8	9	10	Detected PCB Congeners	Reference
Silicone and its precursors	Tubing, glues	Silicone-based glues											1, 2, 3, 4, 6, 7, 8, 9, 11, 13, 15	Anezaki and Nakano (2013)
		Organochlorotins											1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15	Anezaki and Nakano (2013)
		Silicone tubing											44, 45	Cargill (2014)
													44, 45	Rodenburg (2012)
													44/47/65, 45/51, 68	Leidos (2016)
													44/47/65, 45/51, 68	Rodenburg (2016)
		Silicone rubber											4/10, 6, 7/9, 8, 16/32, 17, 18, 19, 24, 25, 26, 28, 33, 40, 42/37, 44, 45, 46, 47/48/49, 51/22, 52, 56/60, 66, 68, 70, 74	Perdih and Jan (1994)
		Silicone-based glues											1, 2, 3, 4, 6, 8, 11, 13, 15	Anezaki and Nakano (2015)
		Chlorophenylsilanes											1, 2, 3, 4, 6, 8, 9, 11, 13, 15, 16, 17, 18, 20/33, 25, 26, 28, 31, 32, 37, 41, 44, 47/58, 49, 52, 53, 64, 65/75, 66, 74	Anezaki and Nakano (2015)
Chlorobenzenes production through chlorination of benzene	Mothballs, room deodorizers, and urinal and toilet blocks (p-DCB)	Reaction product containing various amounts of p-/o-DCB and 1,2,4-/1,2,3-TCB											77, 81, 105, 118[a]	Liu *et al*. (2004)
Chlorinated paraffins	Caulk, metal-working fluids, flame retardants for plastic materials	PUF and rubber materials											–[b]	Takasuga *et al.* (2012)
Cooking of beef with or without chlorinated additives (sucralose, 1,3-dichloropropane-2-ol)	N/A	Cooked and raw beef, oil fumes											All dl-PCBs detected[c]	Dong *et al*. (2011)

Process/Chemical Substance	Product/Industry	Matrix Measured	Homologs (# of Chlorine)										Detected PCB Congeners	Reference
			1	2	3	4	5	6	7	8	9	10		
Synthesis of chloranil	Fungicide; intermediate for production of medicines (diuretics and antisterones), pesticides, and dyes	Chloranil from three different manufacturing plants, different purities											All dl-PCBs detected[c]	Liu *et al*. (2012)
Synthesis of pesticides	Herbicides, fungicides	PCP, CNP, nitrofen, chlorothalonil, MCPA, 2,4-D											All dl-PCBs detected[c]	Masunaga *et al*. (2001)
2,4-D products	Herbicides	2,4-D acid and 2,4-D butyl ester											All dl-PCBs detected[c]	Liu *et al*. (2013a)
Pentachloronitrobenzene (also known as quintozene, terrachlor)	Fungicide	Raw active ingredient, formulations containing 20-40% active ingredient											77, 81, 118, 123, 126, 156, 167, 169,189, 194, 206, 209[d]	Huang *et al*. (2015)
Manufacturing of tetrachloroethenes	Industrial chlorinated solvents	Still bottoms											NM	Erickson *et al*. (1988)
Vinyl chloride	N/A	Vinyl chloride monomer											NM	Erickson *et al*. (1988)
Combustion	Cement kiln, steel sintering furnace, secondary production of zinc, waste incineration	Exhaust gas											2, 3, 12/13, 14, 11, 15, 38, 35, 20/33, 21, 37, 77, 78, 79, 81, 126, 105, 127, 118, 114, 122, 169, 156, 157, 167, 129, 189, 170, 172, 194, 195, 196, 205, 206	Takasuga *et al*. (2014)
Combustion	Iron ore sintering, electric arc furance for steel making, municipal solid waste incineration, medical solid waste incineration and cement kilns	Stack gas from 23 plants											28, 52, 101, 138, 153, 180, 118, All dl-PCBs[e]	Liu *et al*. (2013b)

Process/Chemical Substance	Product/Industry	Matrix Measured	Homologs (# of Chlorine)										Detected PCB Congeners	Reference
			1	2	3	4	5	6	7	8	9	10		
Combustion	Sintering, smelting, waste incineration	Stack gas from nine facilities											Dominant congeners: 105, 118, 126[b]	Kim *et al*. (2005)
	Iron ore sintering	Flue gas											All dl-PCBs detected[c]	Tian *et al*. (2012)
	Thermal treatment plant (automobile shredder fuel, refuse-derived fuel)	Flue gas, intermediate streams											All dl-PCBs detected in final exhaust gas; Other dominant congeners: 12/13, 35, 77, 126 (using refuse derived fuel); 170, 189, 194, 195, 206, 209 (using automobile shredder fuel)	Ishikawa *et al*. (2007)
	Waste incinerators	Fly ash, flue gas											All dl-PCBs detected[c]	Sakai *et al*. (1994)
	Coking industry	Stack gas											All dl-PCBs detected[c]	Cui *et al*. (2013)
	Iron ore sintering	Stack gas, fly ash											All dl-PCBs detected[c]	Li *et al*. (2017)
	Secondary copper smelting	Outlet gas from simulated SeCu process											28, 52, 101, 118, 138, 180, All dl-PCBs detected[e]	Jiang *et al*. (2015)
	Waste incinerators (solid waste, liquid waste, municipal waste)	Flue gas											All congeners except PCB 112 were detected; Combustion-"specific" congeners identified from PCA: 38, 40/57, 77, 81, 107/108, 126, 129, 157, 169, 171, 172/192, 170, 189, 203/196, 194, 206	Kim *et al*. (2004)

Notes:

2,4-D = 2,4-Dichlorophenoxyacetic (acid or ester); CNP = Chloronitrofen; DCB = Dichlorobenzene; dl-PCBs = Dioxin-like PCBs Defined as Congeners; MCPA = 2-Methyl-4-chlorophenoxyacetic Acid; N/A = Not Applicable; NM = Not Measured; PCA = Principal Component Analysis; PCB = Polychlorinated Biphenyl; PCP = Pentachlorophenol; PUF = Polyurethane Foam; SeCu = Selenium Copper; TCB = Trichlorobenzene.

(a) dl-PCBs congeners and homologs measured.

(b) Full congener analysis performed but quantification results not reported.

(c) dl-PCBs congeners only measured.

(d) Study only measured dl-PCBs, 13 other congeners (PCBs 3, 8, 28, 52, 101, 114, 118,138,153,180, 194, 206, 209) and homologs.

(e) Study only measured dl-PCBs, 7 indicator congeners (PCBs 28, 52, 101, 138, 153, 180, 118) and homologs.

Attachment 4

PCB Data Availability Tables

Table A4.1 Matrix of Available Total PCB Data

River Site or Discharger	Location	River Mile	2018	2017	2016	2015	2014	2013	2012	2011	2010	2009	2008	2007	2006	2005	2004	2003	2002	2001	2000	1999	1998	1997	1996	1995	1994	1993	1992	1991	1990
WWTP	City of Spokane WWTP Influent	67.4	No	Yes*	Yes	Yes*	Yes	Yes	Yes	Yes	Yes	No	No	No	No	No	No	No	No	Yes	No	No	No	No	No	No	No	No	No	No	No
	City of Spokane WWTP Effluent	67.4	No	Yes*	Yes	Yes*	Yes	Yes	Yes	Yes	Yes	No	No	No	No	No	Yes	Yes	No	Yes	No	No	No	No	No	No	No	No	No	No	No
	City of Spokane WWTP Biosolids	67.4	No	Yes*	Yes	Yes*	Yes*	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Discharger	Coeur d'Alene WWTP	111.0	No	No	No	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	Post Falls WWTP	102.0	No	No	No	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	Liberty Lake WWTP	92.7	No	No	No	No	Yes	No	No	No	No	No	No	No	No	No	Yes	Yes	No	Yes	No	No	No	No	No	No	No	No	No	No	No
	Kaiser Aluminum	86.0	No	No	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No	No	No	Yes	Yes	Yes	No	Yes	Yes	No	No	No	No	Yes	Yes	No	No	No	No
	Inland Empire Paper	82.5	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No	No	No	Yes	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No
	Spokane County WWTP	78.0	Yes	No	No	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	Hangman Creek	72.8	Yes	No	Yes	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	City of Spokane WWTP	67.4	Yes	No	Yes	No	Yes	Yes	Yes	Yes	Yes	No	No	No	No	No	Yes	Yes	No	Yes	No	No	No	No	No	No	No	No	No	No	No
	Little Spokane River	56.3	No	No	No	No	No	No	No	No	No	No	No	No	No	No	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
River	Lake Coeur d'Alene, ID	111.0	No	No	Yes	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	Post Falls, ID	102.0	No	No	No	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	Stateline	96.1	No	No	No	No	No	Yes	Yes	No	No	No	No	No	No	No	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
	Harvard	92.7	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
	Greenacres/Barker	90.5	Yes	No	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	Yes	No	No	No	No	No	No	No	No	No	No
	Mirabeau Point	86.5	Yes	No	No	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	Trent Bridge	84.3	Yes	No	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
	Upriver Dam	80.3	Yes	No	No	No	No	Yes	Yes	No	No	No	No	No	No	No	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
	Green Street Gage	78.0	Yes	No	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	Monroe Street Gage	74.8	No	No	No	No	No	No	No	No	No	No	No	No	No	No	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
	Spokane Gage	72.9	Yes	No	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	Sandifur Bridge	72.6	No	No	No	No	No	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	Hangman Creek	72.2	Yes	No	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	Nine Mile Dam	63.6	Yes	No	Yes	No	Yes	Yes	Yes	No	No	No	No	No	No	No	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
	Long Lake	38.4	No	No	No	No	No	No	No	No	No	No	No	No	No	No	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
	Tribal Boundary/ Chamokane	32.5	No	No	Yes	No	No	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
MS4/CSO[a]	7[th]		No	No	No	No	No	No	No	No	No	No	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	Clarke		No	No	No	No	No	No	No	No	No	No	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	Cochran		No	No	No	No	Yes	Yes	Yes	No	No	Yes	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	Erie		No	No	No	No	No	No	Yes	Yes	Yes	Yes	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	Greene		No	No	No	No	No	No	No	No	No	Yes	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	Howard Bridge		No	No	No	No	No	No	No	No	No	No	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	H Street		No	No	No	No	No	No	No	No	No	No	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	HWY291		No	No	No	No	No	No	No	No	No	No	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	Lincoln		No	No	No	No	No	No	No	No	No	No	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	Mission		No	No	No	No	No	No	No	No	No	No	No	Yes	No	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	Riverton		No	No	No	No	No	No	No	Yes	No	No	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	Superior		No	No	No	No	No	No	No	No	No	Yes	No	Yes	No	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	Union		No	No	No	No	No	Yes	Yes	Yes	Yes	Yes	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	Washington		No	No	No	No	No	Yes	No	No	No	No	No	Yes	No	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No

River Site or Discharger	Location	River Mile	2018	2017	2016	2015	2014	2013	2012	2011	2010	2009	2008	2007	2006	2005	2004	2003	2002	2001	2000	1999	1998	1997	1996	1995	1994	1993	1992	1991	1990
Interceptor/ SIU	Airway Heights		No	No	No	No	No	No	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	Avon and Crestline		No	No	No	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	Fairchild AFB		No	No	No	No	No	Yes	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	NE Spokane Interceptor		No	No	No	No	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	North Spokane Interceptor		No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	North Valley		No	No	No	No	No	Yes	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	Regal and Grace		No	No	No	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	South Valley		No	No	No	No	No	Yes	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	Broad and Green Interceptor		No	No	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	Lacross and Crestline Interceptor		No	No	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	Hartson and Fiske Interceptor		No	Yes*	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	North Erie Interceptor		No	Yes*	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	West Plains		No	No	No	No	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	Spokane Industrial Park		No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	Yes	No	No	No	No	No	No	No	No	No	No	No

Notes:
AFB = Air Force Base; CSO = Combined Sewer Overflow; MS4 = Municipal Separated Storm Sewer System; PCB = Polychlorinated Biphenyl; Riverside WWTP = Riverside Park Water Reclamation Facility; SIU = Significant Industrial User; WWTP = Wastewater Treatment Plant.
Yellow highlighted cells and * = Data reported as collected but not publicly available.
Data Sources: See Reference list.
(a) Only sampled MS4/CSO basins are listed in the table.

Table A4.2 Matrix of Available Congener-specific PCB Data

River Site or Discharger	Location	River Mile	2018	2017	2016	2015	2014	2013	2012	2011	2010	2009	2008	2007	2006	2005	2004	2003	2002	2001	2000	1999	1998	1997	1996	1995	1994	1993	1992	1991	1990
WWTP	City of Spokane WWTP Influent	67.4	No	Yes*	Yes	Yes*	Yes	Yes	Yes	Yes	Yes	No	No	No	No	No	No	No	No	Yes	No	No	No	No	No	No	No	No	No	No	No
	City of Spokane WWTP Effluent	67.4	No	Yes*	Yes	Yes*	Yes	Yes	Yes	Yes	Yes	No	No	No	No	No	Yes	Yes	No	Yes	No	No	No	No	No	No	No	No	No	No	No
	City of Spokane WWTP Biosolids	67.4	No	Yes*	Yes	Yes*	Yes*	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Discharger	Coeur d'Alene WWTP	111.0	No	No	No	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	Post Falls WWTP	102.0	No	No	No	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	Liberty Lake WWTP	92.7	No	No	No	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	Yes	No	No	No	No	No	No	No	No	No	No	No
	Kaiser Aluminum	86.0	No	No	No	Yes	Yes	No	No	No	No	No	No	No	No	Yes	Yes	Yes	No	Yes	No	No	No	No	No	No	No	No	No	No	No
	Inland Empire Paper	82.5	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No	No	No	Yes	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No
	Spokane County WWTP	78.0	Yes	No	No	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	Hangman Creek	72.8	Yes	No	Yes	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	City of Spokane WWTP	67.4	Yes	Yes*	Yes	Yes*	Yes	Yes	Yes	Yes	Yes	No	No	No	No	No	Yes	Yes	No	Yes	No	No	No	No	No	No	No	No	No	No	No
	Little Spokane River	56.3	No	No	No	No	No	No	No	No	No	No	No	No	No	No	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
River	Lake Coeur d'Alene, ID	111.0	No	No	Yes	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	Post Falls, ID	102.0	No	No	No	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	Stateline	96.1	No	No	No	No	No	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	Harvard	92.7	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
	Greenacres/Barker	90.5	Yes	No	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	Mirabeau Point	86.5	Yes	No	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	Trent Bridge	84.3	Yes	No	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
	Upriver Dam	80.3	Yes	No	No	No	No	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	Green Street Gage	78.0	Yes	No	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	Monroe Street Gage	74.8	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	Spokane Gage	72.9	Yes	No	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	Sandifur Bridge	72.6	No	No	No	No	No	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	Hangman Creek	72.2	Yes	No	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	Nine Mile Dam	63.6	Yes	No	Yes	No	Yes	Yes	Yes	No	No	No	No	No	No	No	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
	Long Lake	38.4	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	Tribal Boundary/ Chamokane	32.5	No	No	Yes	No	No	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
MS4/CSO[a]	7th		No	No	No	No	No	No	No	No	No	No	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	Clarke		No	No	No	No	No	No	No	No	No	No	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	Cochran		No	No	No	No	Yes	Yes	Yes	No	No	Yes	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	Erie		No	No	No	No	No	No	Yes	Yes	No	Yes	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	Greene		No	No	No	No	No	No	No	No	No	Yes	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	Howard Bridge		No	No	No	No	No	No	No	No	No	No	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	H Street		No	No	No	No	No	No	No	No	No	No	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	HWY291		No	No	No	No	No	No	No	No	No	No	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	Lincoln		No	No	No	No	No	No	No	No	No	No	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	Mission		No	No	No	No	No	No	No	No	No	No	No	Yes	No	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	Riverton		No	No	No	No	No	No	No	Yes	No	No	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	Superior		No	No	No	No	No	No	No	No	No	Yes	No	Yes	No	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	Union		No	No	No	No	No	Yes	Yes	Yes	Yes	Yes	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	Washington		No	No	No	No	No	Yes	No	No	No	No	No	Yes	No	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No

River Site or Discharger	Location	River Mile	2018	2017	2016	2015	2014	2013	2012	2011	2010	2009	2008	2007	2006	2005	2004	2003	2002	2001	2000	1999	1998	1997	1996	1995	1994	1993	1992	1991	1990
Interceptor/ SIU	Airway Heights Interceptor		No	No	No	No	No	No	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	Avon and Crestline Interceptor		No	No	No	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	Fairchild AFB Interceptor		No	No	No	No	No	Yes	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	NE Spokane Interceptor		No	No	No	No	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	North Spokane Interceptor		No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	North Valley Interceptor		No	No	No	No	No	Yes	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	Regal and Grace Interceptor		No	No	No	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	South Valley Interceptor		No	No	No	No	No	Yes	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	Broad and Green Interceptor		No	No	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	Lacross and Crestline Interceptor		No	No	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	Hartson and Fiske Interceptor		No	Yes*	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	North Erie Interceptor		No	Yes*	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	West Plains Interceptor		No	No	No	No	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	Spokane Industrial Park		No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	Yes	No	No	No	No	No	No	No	No	No	No	No

Notes:
AFB = Air Force Base; CSO = Combined Sewer Overflow; MS4 = Municipal Separated Storm Sewer System; PCB = Polychlorinated Biphenyl; Riverside WWTP = Riverside Park Water Reclamation Facility; SIU = Significant Industrial User; WWTP = Wastewater Treatment Plant.
Yellow highlighted cells and * = Data reported as collected but not publicly available.
Data Sources: See Reference list.
(a) Only sampled MS4/CSO basins are listed in the table.

Table A4.3 Matrix of Available Total PCB and Flow Data (*i.e.*, Load Data)

River Site or Discharger	Location	River Mile	2018	2017	2016	2015	2014	2013	2012	2011	2010	2009	2008	2007	2006	2005	2004	2003	2002	2001	2000	1999	1998	1997	1996	1995	1994	1993	1992	1991	1990
Discharger	Coeur d'Alene WWTP	111	No	No	No	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	Post Falls WWTP	102	No	No	No	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	Liberty Lake WWTP	92.7	No	No	No	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	Yes	No	No	No	No	No	No	No	No	No	No	No
	Kaiser Aluminum	86	No	No	No	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	Inland Empire Paper	82.5	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No	No	No	Yes	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No
	Spokane County WWTP	78	Yes	No	No	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	Hangman Creek	72.8	No	No	Yes	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	City of Spokane WWTP	67.4	Yes	No	No	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	Yes	No	No	No	No	No	No	No	No	No	No	No
	Little Spokane River	56.3	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
River	Lake Coeur d'Alene, ID	111	Yes	No	Yes	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	Post Falls, ID	102	Yes	No	No	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	Stateline	96.1	No	No	No	No	No	Maybe	Maybe	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	Harvard	92.7	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	Greenacres/Barker	90.5	Yes	No	No	Maybe	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	Mirabeau Point	86.5	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	Trent Bridge	84.25	Yes	No	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	Upriver Dam	80.3	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	Green Street Gage	78	Yes	No	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	Monroe Street Gage	74.8	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	Spokane Gage	72.9	Yes	No	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	Sandifur Bridge	72.6	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	Hangman Creek	72.2	No	No	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	Nine Mile Dam	63.6	Yes	No	Yes	No	Yes	No	No	No	No	No	No	No	No	No	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
	Long Lake	38.4	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	Tribal Boundary/ Chamokane	32.5	No	No	Maybe	No	No	Maybe	Maybe	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
MS4/CSO[a]	7th		No	No	No	No	No	No	No	No	No	No	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	Clarke		No	No	No	No	No	No	No	No	No	No	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	Cochran		No	No	No	Yes	No	No	No	No	No	No	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	Erie		No	No	No	No	No	No	No	No	No	No	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	Greene		No	No	No	Yes	No	No	No	No	No	No	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	Howard Bridge		No	No	No	Yes	No	No	No	No	No	No	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	H Street		No	No	No	Yes	No	No	No	No	No	No	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	HWY 291		No	No	No	Yes	No	No	No	No	No	No	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	Lincoln		No	No	No	Yes	No	No	No	No	No	No	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	Mission		No	No	No	Yes	No	No	No	No	No	No	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	Riverton		No	No	No	Yes	No	No	No	No	No	No	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	Superior		No	No	No	Yes	No	No	No	No	No	No	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	Union		No	No	No	Yes	No	No	No	No	No	No	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	Washington		No	No	No	Yes	No	No	No	No	No	No	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No

River Site or Discharger	Location	River Mile	2018	2017	2016	2015	2014	2013	2012	2011	2010	2009	2008	2007	2006	2005	2004	2003	2002	2001	2000	1999	1998	1997	1996	1995	1994	1993	1992	1991	1990
Interceptor/ SIU	Airway Heights Interceptor		No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	Avon and Crestline Interceptor		No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	Fairchild AFB Interceptor		No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	NE Spokane Interceptor		No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	North Spokane Interceptor		No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	North Valley Interceptor		No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	Regal and Grace Interceptor		No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	South Valley Interceptor		No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	Broad and Green Interceptor		No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	Lacross and Crestline Interceptor		No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	Hartson and Fiske Interceptor		No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	North Erie Interceptor		No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	West Plains Interceptor		No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	Spokane Industrial Park		No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No

Notes:
AFB = Air Force Base; CSO = Combined Sewer Overflow; MS4 = Municipal Separated Storm Sewer System; PCB = Polychlorinated Biphenyl; Riverside WWTP = Riverside Park Water Reclamation Facility; SIU = Significant Industrial User; WWTP = Wastewater Treatment Plant.
Maybe = Sampling was indicated to have occurred but analytical results were not identified.
Data Sources: See Reference list.
(a) Only sampled MS4/CSO basins are listed in the table.

References

Donovan, J. [Spokane, Washington, RPWRF Laboratory]. 2012. "2011 Annual Summary of RPWRF Toxics Monitoring." 114p., March 9.

Donovan, J. [Spokane, Washington, RPWRF Laboratory]. 2013. "2012 Annual Summary of RPWRF Toxics Monitoring." 80p., August 20.

Donovan, J. [Spokane, Washington, RPWRF Laboratory]. 2014. "2013 Annual Summary of RPWRF Toxics Monitoring." 89p., April 9.

Donovan, J. [Spokane, Washington, RPWRF Laboratory]. 2015. "2014 Annual Summary of RPWRF Toxics Monitoring." 71p., September 9.

Donovan, J. [Spokane, Washington, RPWRF Laboratory]. 2016. "2015 Annual Summary of RPWRF Toxics Monitoring." 59p., September 8.

Donovan, J. [Spokane, Washington, RPWRF Laboratory]. 2017. "2016 Annual Summary of RPWRF Toxics Monitoring." 67p., September 11.

Inland Empire Paper Co. (IEP). 2013. "Inland Empire effluent, process water, and product sample results (2002-2013)." 2235p. [IEP_SPO_TP0000000624 - IEP_SPO_TP0000002858]

Inland Empire Paper Co. (IEP). 2015a. "Inland Empire effluent sample results (August 2015)." 8p. [IEP_SPO_TP0000005930 - IEP_SPO_TP0000005937]

Inland Empire Paper Co. (IEP). 2015b. "Inland Empire Paper Company NPDES Permit No. WA-000082-5 Permit Condition S6.A: Polychlorinated Biphenyl Source Identification Study." 60p., October 30.

Inland Empire Paper Co. (IEP). 2016a. "Inland Empire effluent sample results (2014-2016)." 776p. [IEP_SPO_TP0000004870 - IEP_SPO_TP0000005645]

Inland Empire Paper Co. (IEP). 2016b. "Inland Empire effluent sample results (December 2015 and January 2016)." 14p. [IEP_SPO_TP0000005938 - IEP_SPO_TP0000005951]

Inland Empire Paper Co. (IEP). 2016c. "Inland Empire effluent sample results (August 2016)." 14p. [IEP_SPO_TP0000005966 - IEP_SPO_TP0000005979]

Inland Empire Paper Co. (IEP). 2016d. "Inland Empire effluent sample results (December 2016)." 8p. [IEP_SPO_TP0000005980 - IEP_SPO_TP0000005987]

Inland Empire Paper Co. (IEP). 2016e. "Inland Empire Paper Company NPDES Permit No. WA-000082-5 Permit Condition S6.B: Polychlorinated Biphenyls Best Management Practices Plan Update, 2016 Report." 24p., November 1.

Inland Empire Paper Co. (IEP). 2017a. "Inland Empire effluent sample results (March 2017)." 14p. [IEP_SPO_TP0000005952 - IEP_SPO_TP0000005965]

Inland Empire Paper Co. (IEP). 2017b. "Inland Empire effluent sample results (July 2017)." 10p.

Inland Empire Paper Co. (IEP). 2017c. "Inland Empire Paper Company (IEP) 2017 Q1 PCB results." March 14.

LimnoTech. 2016. "2016 Comprehensive Plan to Reduce Polychlorinated Biphenyls (PCBs) in the Spokane River." Report to Spokane River Regional Toxics Task Force. 125p., November 29.

LimnoTech. 2017. Memorandum to Spokane River Regional Toxics Task Force re: Review Draft: Homolog-Specifics PCB Mass Balance for the Spokane River. 22p., July 19.

Parsons. 2007. "Spokane River PCB TMDL Stormwater Loading Analysis (Final Technical Report)." Report to US EPA Region X; Washington State Dept. of Ecology (WA Ecology). Publication No. 07-03-055. 52p., December.

Science Applications International Corp. (SAIC). 2003. "Final Report of Wastewater and Sludge Sampling at Inland Empire Paper Company, Spokane, Washington (Revision 1)." Report to Washington State Dept. of Ecology (WA Ecology). 74p., April 4.

Spokane County Environmental Services Dept.; Washington State Dept. of Ecology (WA Ecology). 2017. "SVRP Aquifer PCB Characterization Sampling Results (Final Report)." Report to Spokane River Regional Toxics Task Force. 78p., May.

Spokane, Washington, Wastewater Management Dept. (SWWM). 2014. "2014 Annual Report: Adaptive Management Plan for Reducing PCBs in Stormwater Discharges (Reporting Period: May, 2013 to May, 2014)." 53p., June.

Washington State Dept. of Ecology (WA Ecology). 2001-2014. "River and Stream Water Quality Monitoring Reports, Water Years 2000-2013."

Washington State Dept. of Ecology (WA Ecology). 2002. "Spokane Area Point Source PCB Survey, May 2001." Publication No. 02-03-009. 94p., March.

Washington State Dept. of Ecology (WA Ecology). 2010. "PCBs, Dioxins, and Furans in Fish, Sediment, and Wastewater Treatment Plant Effluent from West Medical Lake." Environmental Assessment Program, Toxics Studies Unit. Publication No. 10-03-038. 51p., September.

Washington State Dept. of Ecology (WA Ecology). 2011. "Spokane River PCB Source Assessment, 2003-2007." Publication No. 11-03-013, 156p., April.

Washington State Dept. of Ecology (WA Ecology). 2012a. "Spokane River Urban Waters Source Investigation and Data Analysis Progress Report (2009-2011): Source Tracing for PCB, PBDE, Dioxin/Furan, Lead, Cadmium, and Zinc." Publication No. 12-04-025. 92p.

Washington State Dept. of Ecology (WA Ecology). 2012b. "Liberty Lake Source Trace Study Regarding PCB, PBDE, Metals, and Dioxin/Furan: A Pilot Project for Spokane Basin Source Tracing (Revised)." Publication No. 10-04-027. 68p., October.

Washington State Dept. of Ecology (WA Ecology). 2013. "Quality Assurance Project Plan, Spokane River Toxics Fish Tissue and Preliminary Monitoring in Fiscal Year 2013 in Support of the Long-term Toxics Monitoring Strategy." Publication No. 13-03-103. 36p., January.

Washington State Dept. of Ecology (WA Ecology). 2017. "Spokane River PCBs and Other Toxics at the Spokane Tribal Boundary: Recommendations for Developing a Long-Term Monitoring Plan." Publication No. 17-03-019. 59p., December.

Washington State Dept. of Ecology (WA Ecology). 2018a. "Evaluation of Fish Hatcheries as Sources of PCBs to the Spokane River." Environmental Assessment Program, Toxics Studies Unit. Publication No. 18-03-014. 44p., April. Accessed at https://fortress.wa.gov/ecy/publications/documents/1803014.pdf.

Washington State Dept. of Ecology (WA Ecology). 2018b. "Study Data Summary: Spokane River Urban Waters - Spokane River Source Trace Study Regarding PCB, PBDE, Metal, and Dioxin/Furan Contamination (SRUW-Spokane)." Environmental Information Management System (EIMS). Accessed at https://fortress.wa.gov/ecy/eimreporting/Detail/Detail.aspx?DetailType=Study&SystemProjectId=56465545.

Washington State Dept. of Ecology (WA Ecology). 2019. "Evaluation of Low-Level Field Sampling Methods for PCBs and PBDEs in Surface Waters." Environmental Assessment Program, Toxics Studies Unit. Publication No. 19-03-002. 70p., January.

Attachment 5

Upland PCB Sites in the Spokane River Watershed

Table of Contents

List of Tables

**Embedded in text.*

List of Charts

All Charts are embedded in the text.

List of Figures

All Figures are appended at the end of the Attachment.

A5.1 Introduction

This attachment summarizes the approach used to identify sites where polychlorinated biphenyls (PCBs) were used and/or released within the Spokane River watershed. This work was performed to understand the relative significance of those sites as a source of PCBs within the watershed, the PCB release mechanism(s) at those sites, and PCB source types (*e.g.*, byproduct PCB, closed source).

Over the last two decades, several organizations have worked on identifying the most significant sources of PCBs in the Spokane River watershed. The Washington State Department of Ecology (WA Ecology) conducted their first point source surveys in the early 1990s (WA Ecology, 1995) and has performed a series of PCB-related studies that continue through current day. The United States Environmental Protection Agency (US EPA) and WA Ecology have been the lead agencies identifying and responding to PCB releases at certain sites (*e.g.*, General Electric [GE] Spokane Yard, Spokane Junkyard). In 2012, the Spokane River Regional Toxics Task Force (referred to as the Task Force herein) was established, with the goal of developing a comprehensive plan for reducing the PCB load in the Spokane River through a partnership between the following entities (WA Ecology, 2012a):

- Federal, state and municipal government agencies, including US EPA, WA Ecology, Spokane County, and the City of Spokane;
- Non-governmental organizations, including the Spokane Riverkeeper and the Lands Council; and
- Private companies that discharge to the Spokane River, including Kaiser Aluminum and the Inland Empire Paper Company (IEP).

Participation in the Task Force is required by WA Ecology for all permitted industrial and municipal wastewater dischargers to the Spokane River (WA Ecology, 2012a).

The PCB site research described herein builds on, but is not limited to, the work of groups including US EPA, WA Ecology, and the Task Force.

I identified and categorized potential sites of interest into four categories, shown in Chart A5.1:[1] Release, Permitted Discharger, User, and Disposal sites. The following charts indicate the main information sources used to identify potential sites (top rows) and the outcome of this research (shown in the bottom row).

[1] Note that some sites may fall into several categories, *e.g.*, a site such as Kaiser Aluminum, with historical releases of PCBs to soil and groundwater that also discharges PCB-containing wastewater directly to the Spokane River.

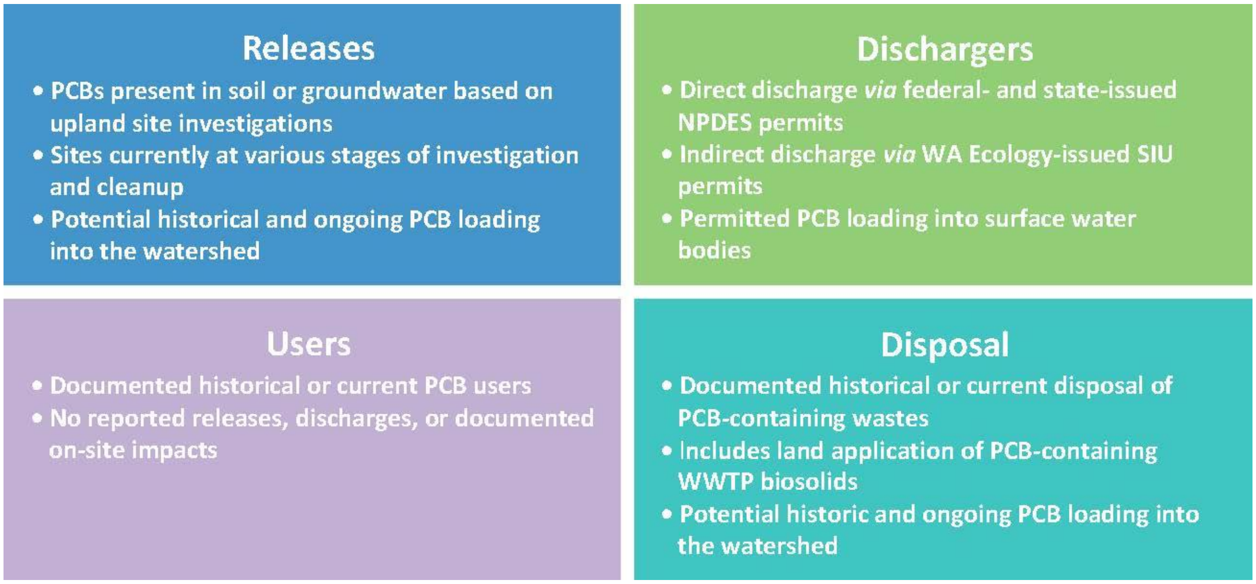


Chart A5.1 Upland Site Categories. PCB = Polychlorinated Biphenyl; NPDES = National Pollutant Discharge Elimination System; SIU = Significant Industrial User; WA Ecology = Washington State Department of Ecology; WWTP = Wastewater Treatment Plant.

Release: This category includes sites where sampling confirms that PCBs have been released into soil and/or groundwater at the site, with subsequent potential transport (*e.g.*, stormwater runoff) into the Spokane River. The purpose of identifying such sites is to understand which sites have contributed to historical and ongoing PCB loads in the watershed.

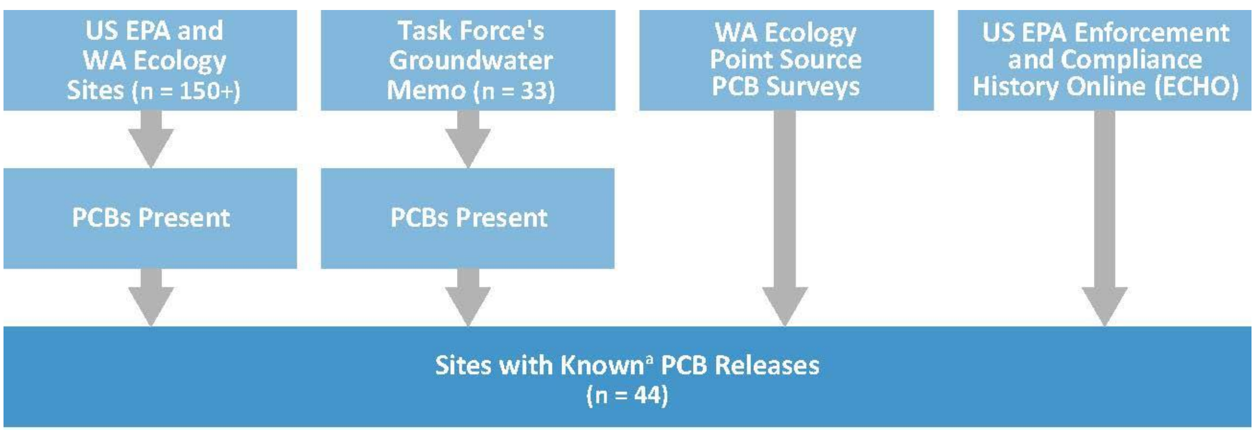


Chart A5.2 Upland Sites: Release Sites. PCB = Polychlorinated Biphenyl; Task Force = Spokane River Regional Toxics Task Force; US EPA = United States Environmental Protection Agency; WA Ecology = Washington State Department of Ecology. n = Number of sites identified at each step. Potential sources are listed in Table A5.1. (a) Includes sites with suspected PCB concentrations above relevant screening levels.

Permitted Discharger: This category includes sites that are permitted to discharge wastewater and/or stormwater to the Spokane River or its tributaries under the National Pollutant Discharge Elimination System (NPDES) permitting program administered primarily by WA Ecology and US EPA[2] or to the City of Spokane wastewater treatment plant (WWTP) under the Significant Industrial User (SIU) permitting program.[3] The discharges from these sites represent an ongoing PCB load to the Spokane River – directly, in the case of NPDES-permitted discharges, and indirectly, in the case of the SIU-permitted discharges. The purpose of identifying these sites is to understand their potential PCB mass loading to the Spokane River.

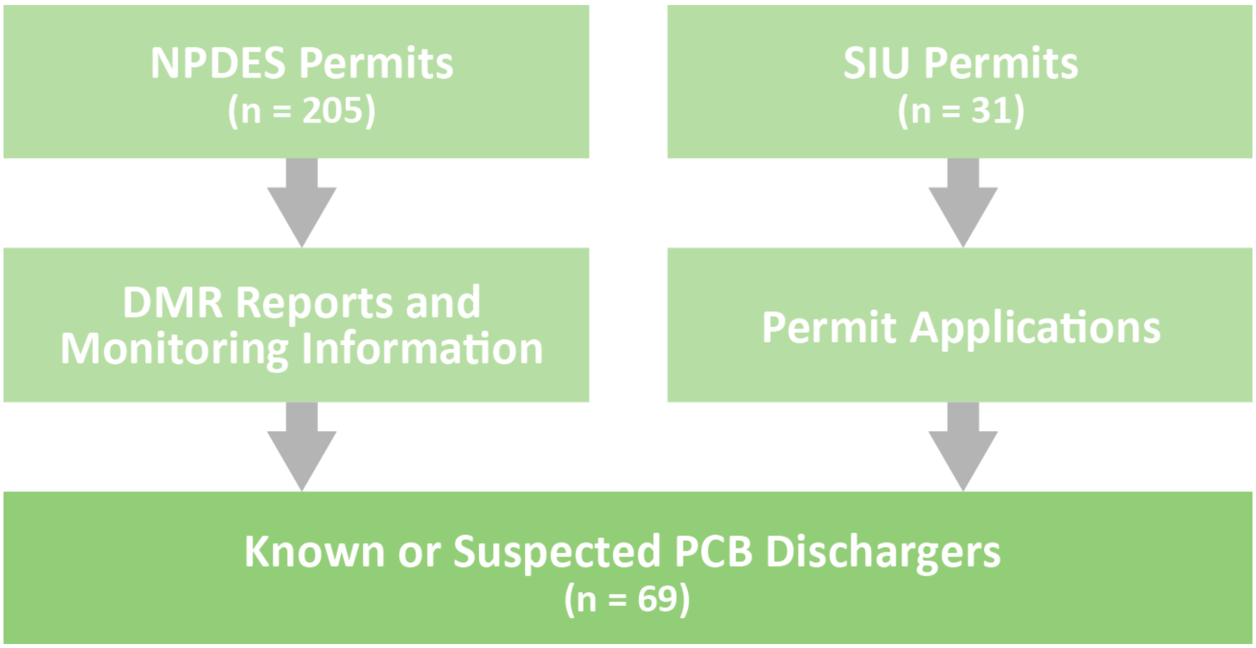


Chart A5.3 Upland Sites: Permitted Discharger Sites. DMR = Discharge Monitoring Report; NPDES = National Pollutant Discharge Elimination System; PCB = Polychlorinated Biphenyl; SIU = Significant Industrial User. n = Number of sites identified at each step. Potential sources are listed in Table A5.1.

User: This category includes sites with documented historical or current PCB uses, but with no reported releases, discharges, or documented on-site impacts. These sites demonstrate that PCBs may be used without any identified environmental release or on-site impacts at the facilities or their surrounding areas. Facilities in this category were identified using US EPA-maintained databases associated with PCB use and compliance under the Toxic Substances Control Act (TSCA). Additional facilities were identified using Monsanto Customer Records and Invoices.

[2] WA Ecology administers the NPDES program in Washington, excluding the tribal reservations. US EPA has administered the NPDES program in Idaho, but is currently transitioning the administration of these permits to the Idaho Department of Environmental Quality (IDDEQ).

[3] While the SIU permits are issued by the City of Spokane Wastewater Management Department (SWWM), these permits are included in the City's NPDES application, which is administered by WA Ecology (SWWM, 2015a).

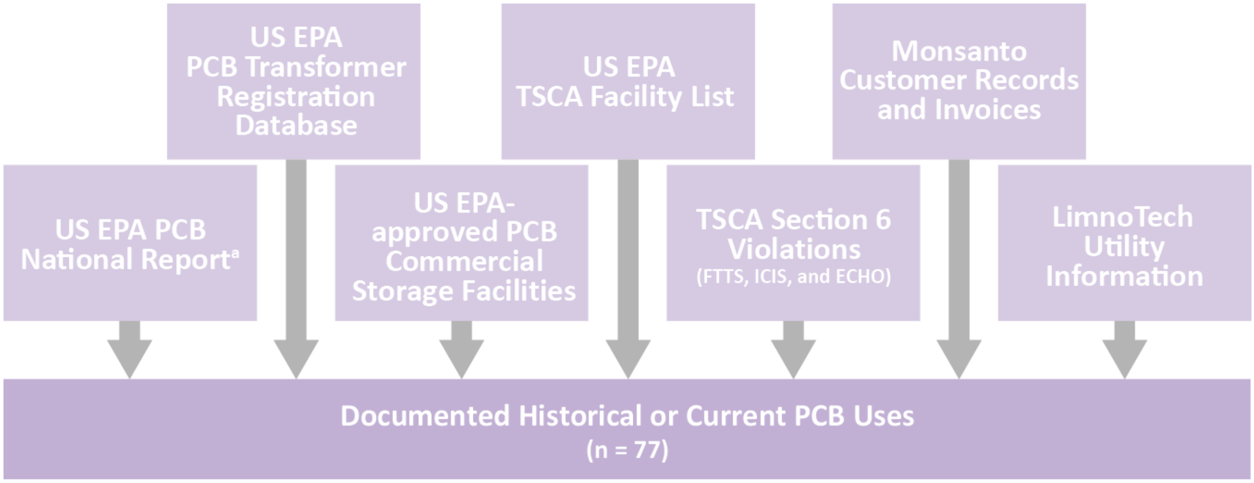


Chart A5.4 Upland Sites: User Sites. ECHO = Enforcement and Compliance History Online; FTTS = Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA)/TSCA Tracking System; ICIS = Integrated Compliance Information System; PCB = Polychlorinated Biphenyl; TSCA = Toxic Substances Control Act; US EPA = United States Environmental Protection Agency. Potential sources are listed in Table A5.1. (a) Also known as the Notifications for PCB Activity Database (PADS) or the PCB Waste Handlers database.

Disposal: This category consists of disposal sites (*e.g.*, landfills) where PCB-containing wastes may have historically been or are currently placed for disposal. This category also includes locations where PCB-containing WWTP biosolids (sludge) has been placed for agricultural use. Facilities in this category were identified using US EPA-maintained databases associated with PCB disposal and state inventories of solid waste disposal facilities. Additional disposal sites have been identified through research on known release sites.

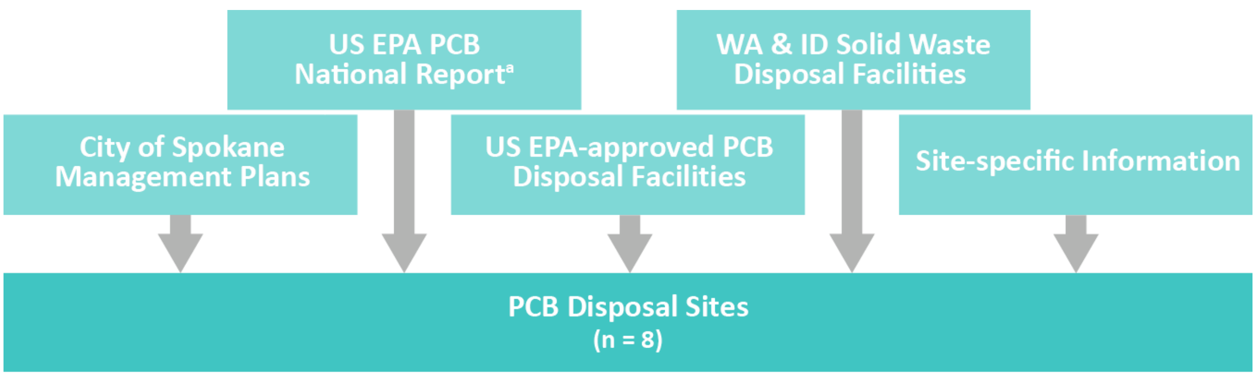


Chart A5.5 Upland Sites: Disposal Sites. ID = Idaho; PCB = Polychlorinated Biphenyl; US EPA = United States Environmental Protection Agency; WA = Washington. n = Number of sites identified at each step. Potential sources are listed in Table A5.1. (a) Also known as the Notifications for PCB Activity Database (PADS) or the PCB Waste Handlers database.

The methodology for identifying sites within each category is described in Section A5.2. The summary of the results of this site identification research are presented in Section A5.3.

A5.2 Upland PCB Site Identification and Research Methodology

In order to identify and research upland PCB sites falling into one or more of the categories described in Section A5.1, I relied upon the following information types: (1) prior work on this topic performed by the Task Force and by WA Ecology, including the Task Force's groundwater memo (SRRTTF, 2015) and the three Point Source Surveys of the Spokane River conducted by WA Ecology (WA Ecology, 1995, 2001, 2002); (2) publicly available information and reports obtained *via* literature searches; and (3) documents obtained through the discovery process in this case. Once the relevant sites were identified, additional information was obtained to further understand each site's operational history, PCB uses/sources, the nature and extent of the PCBs' presence, and any remediation activities conducted. This information was also used to assess the potential magnitude of PCB releases to the watershed from these sites. These information sources are described in Table A5.1.

The resources listed in Table A5.1 were used to identify upland PCB sites for each of the four categories, as described below.

Release: This category includes current and historically impacted sites, including those with suspected releases. WA Ecology maintains the Cleanup Site Details and the Confirmed and Suspected Contaminated Sites List (CSCSL) (WA Ecology, 2017a,b), which included information about the chemicals present and the exposed media.[4] Eighty-one sites with PCB or halogenated organics[5] present above screening levels in any media were listed. If only halogenated organics were identified on the list, then the site documents were reviewed further to determine if PCBs were present. This approach was used to identify several of the Formerly Used Defense Sites (FUDS). Overall, 34 sites with PCBs in soils and/or groundwater above screening levels were identified on WA Ecology-maintained lists.

Additional sites were also identified using the following sources.

- The Task Force's "Assessment of PCBs in Spokane Valley Groundwater" (SRRTTF, 2015): All the sites identified in this report were included in the Releases category. Information related to the potential impacts associated with some of these sites is not publically available; thus, the status of some sites has not been independently verified.
- Additional information on some sites was reported in the PCB point source surveys conducted by WA Ecology (1995, 2001, 2002).
- If in the course of researching sites under the other categories, a PCB release was identified, then the site was also added to the Releases category. For example, one Release site (BNSF's 6401 N Freya Street Site) was identified during the search for PCBs Users using the US EPA's Enforcement and Compliance History Online database (ECHO; US EPA, 2019a).

[4] This list includes "sites where Ecology has confirmed contamination actually exists or are sites where Ecology strongly suspects contamination is present (*e.g.*, buried drums), even though [Ecology] may not yet have actual test results of contamination" (WA Ecology, 2009).
[5] The halogenated organics category includes volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), organochlorine pesticides, PCBs, dioxins, and furans.

The Releases category includes 44 sites with suspected or confirmed PCB impacts.

Permitted Discharger: This category includes regulatory-permitted discharges, in which PCBs may be present or regulated in some way (*e.g.*, monitoring requirements, mass loading limits, or through best management practices). Facilities in this category were identified using information gathered for NPDES-permitted discharges. NPDES permit holders were identified using the US EPA's Discharge Monitoring Report (DMR) Pollutant Loading Tool (US EPA, 2017a). In addition, sites with SIU permits and discharging into the Riverside Park Water Reclamation Facility (Riverside WWTP) or the Spokane County Regional Water Reclamation Facility (SCRWRF) were also included in this category. These sites were identified using the NPDES permit applications for the two water reclamation facilities (SWWM, 2015a; SCPWD, 2015), as well as through the City of Spokane's response to special interrogatories (Spokane, Washington, 2017a). A total of 31 unique SIU sites were identified; 14 are listed in the Riverside WWTP NPDES permit, 8 are listed in the Spokane County NPDES permit, and 8 were identified by the City of Spokane from their historical records search.[6] In addition, the Spokane Industrial Park currently discharges its industrial (and sanitary) wastewater to the Riverside WWTP *via* the City of Spokane sewer system, which began in 1993 (WA Ecology, c. 1991, 1996; PTI Environmental Services, 1995).

The City of Spokane WWTP and the City's combined sewer overflow (CSO) and municipal separated storm sewer system (MS4) sewer conveyance systems and discharge points are included in the Permitted Dischargers category.

The DMR lists 205 NPDES permits issued within the Spokane River watershed, including the two Spokane water reclamation facilities (US EPA, 2017a). However, PCB concentrations are not reported in the DMR for any of the facilities (US EPA, 2017a). In order to identify facilities in which PCBs may be present or regulated in some way, and therefore included in the Permitted Dischargers category, the permits were reviewed to identify:

- All permits related to water treatment plants (designated as a publicly owned treatment works [POTW] in the DMR or with related facility names, including WWTP, water treatment plant [WTP], or sewage treatment plant [STP]);
- All permits related to MS4s (also labeled as "Municipal SW Phase II" in Washington); and
- Any site-specific permit stating that PCBs are regulated in some way.

In Washington State, WA Ecology issues both general use permits (permit numbers begin with WAG, WAL, or WAR) and site-specific permits (permit numbers begin with WA0) (US EPA Region X, 2014a). A majority of the permits issued by WA Ecology are publically available (only 4 out of 105 permits were not found in the Water Quality Permitting and Reporting System [PARIS] database; WA Ecology, 2018a). The seven permits related to WTPs had site-specific permits (WA0); of these, only four have PCB-related requirements. The four permits related to MS4 systems are regulated under the general Municipal Stormwater Phase II (WAR) permit. WA Ecology issued a revised draft general permit for Eastern Washington in August 2019 and it includes no PCB-specific requirements. The only total maximum daily loads (TMDLs) established for the river and Lake Spokane (with the City of Spokane limits) are for phosphorus, ammonia, carbonaceous biological oxygen demand (CBOD), and flow rates (WA Ecology, 2014a, 2018b, 2019). The general permits issued for sand and gravel (WAG); construction stormwater (WAR); and industrial stormwater (WAR) were not individually reviewed, as PCB-related information is not included in these general permits (WA Ecology, 2015a, 2017e, 2018c). The three fish hatcheries are covered by two permits that include PCB-related requirements; Spokane State Hatchery is regulated by a

[6] Mica Landfill has been included under both facilities' permits; the landfill is categorized under Disposal.

WA Ecology permit (WAG137007), while the Spokane Tribal and Ford State hatcheries are covered under a US EPA Region X permit (WAG130000, WAG130009, WAG130019) (WDFW, 2015a; US EPA Region X, 2016). The remaining (non-POTW) site-specific permits were reviewed: two permits are inactive and two are industrial permits (IEP and Kaiser Aluminum) that have PCB-related requirements (IEP: WA NPDES, WA0000825 [WA Ecology, 2011a] and Kaiser Aluminum: WA NPDES, WA0000892 [WA Ecology, 2014b]).

In Idaho, US EPA has issued all of the general (permit number begins with IDL, IDR, or IDS) and site-specific permits (permit number begins with ID0) (IDDEQ, 2016, 2017). US EPA is currently transitioning administration of these permits to IDDEQ. To date, no new permits have been issued by IDDEQ, and the expired US EPA permits have been administratively extended in the meantime (Idaho Administrative Code and IDDEQ, 2019; IDDEQ, 2019). A majority of the permits issued by US EPA in Idaho are available publically (only 3 out of 100 permits were not found on the US EPA-administered Idaho NPDES Permits database; US EPA, 2018a). All of the IDL permit locations also have site-specific permits, which were reviewed. The general permits issued for construction stormwater (IDR) were not individually reviewed, as PCB-related information is not included in these general permits. The MS4 permits (IDS) were all reviewed: two facilities also had a site-specific permit (Coeur d' Alene and Post Falls WWTP), two permits did not include PCB-related requirements, and one permit did (Post Falls ID Transportation, District 1). The site-specific permits were issued either for forestry or mining operations (7 permits) or for WTPs (12 permits). Only three of the site-specific WTP permits (Hayden, Post Falls, and Coeur d' Alene) and one MS4 permit (IDS) include PCB-related requirements and are therefore included in the Permitted Dischargers group.

Based on the review of the permitted discharges, 49 locations in Washington state and 20 locations in Idaho were identified in which PCBs may be present or are regulated, and are therefore included in the Permitted Dischargers group.

Table A5.2 Permitted Dischargers Search Criteria and Results

Discharger Type	Washington	Idaho
SIU	31 facilities discharging into the Riverside Park Water Reclamation Facility (Riverside WWTP) or the Spokane County Regional Water Reclamation Facility (SCRWRF)	Not evaluated
Water Treatment Plant	9 permits (3 with PCB-related requirements)	12 permits (3 with PCB-related requirements)
MS4	4 permits	5 permits (3 unique facilities)
Others with PCB-related requirements	5 permits (3 fish hatcheries, Kaiser Aluminum and IEP)	4 permits (fish hatchery, 2 mines and Potlach Corp.)

Notes:
IEP = Inland Empire Paper Company; MS4 = Municipal Separate Storm Sewer Systems; PCB = Polychlorinated Biphenyl; SIU = Significant Industrial User; WWTP = Wastewater Treatment Plant.

User: This category includes sites with documented historical or current PCB uses, but with no reported releases, discharges, or documented on-site PCB impacts. Sites in this category were identified using US EPA-maintained databases associated with PCB use and compliance under TSCA (see below), as well as Monsanto Customer Records and Invoices (Monsanto Co., 1977a,b), and the LimnoTech PCB reduction report (LimnoTech, 2016). I considered both sites with current and historical PCB uses. If the sites identified in these databases and other sources were found to also have releases or discharges, or to have disposed of PCBs, they were assigned to the Releases, Permitted Dischargers, or Disposal categories,

respectively, instead of the Users category. US EPA maintains four lists of facilities with current TSCA-permitted PCB uses:

- **US EPA's PCB National Report (US EPA, 2017b):** Also known as the Notifications for PCB Activity Database (PADS) or the PCB Waste Handlers database. This report identifies and classifies sites by the type of PCB activity (generator, storer, transporter, disposer, research facility, and/or smelter[7]) and was last updated in 2017. All sites present within Spokane or Kootenai County were reviewed.
  - If the sites were identified as a generator, storer, transporter, or research facility, and were not included in the other categories (namely Releases, Permitted Discharger, or Disposal), the sites were added to the Users category. The disposer and smelter categories were added to the Disposal category.
- **US EPA's Regulated Transformers (US EPA, 2015a):** All transformers that have PCBs present at greater than 500 parts per million (ppm) in transformer oils are required to be registered; additional transformers with lower concentrations may also be included. This database was last updated in 2015. All sites present within Spokane or Kootenai County were added to the Users category.
- **US EPA's Approved PCB Commercial Storage and Disposal Facilities (US EPA, 2018b):** List of facilities that are permitted by US EPA to store PCB waste prior to proper disposal. This database was last updated in 2018. No facilities were identified within Spokane or Kootenai County. (The one facility marked as a "storer" in the PADS list is not included in this database.)
- **US EPA's TSCA Facility List:** Identified manufacturers and importers of substances that are included on the TSCA Chemical Substance Inventory list; PCBs are included on the Inventory List. I obtained this list from the EDR reports (EDR, 2017a,b), which are current as of the end of 2012, when US EPA stopped updating the list. None of the sites identified in the EDR reports were manufacturers or importers of PCBs; thus, no additional facilities were identified from this source.

In addition, multiple platforms have been used by US EPA over time to track information about historical PCB regulation under TSCA:

- **US EPA's PCB National Reports from 2009, 2010, and 2011 (US EPA, 2009, 2010, 2011):** These versions identified and classified facilities using the same approach that is currently used. The 2009 and 2010 versions only includes facilities in Washington State, while the 2011 version includes all of US EPA Region X. No additional sites were identified.
- **US EPA's Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) and TSCA Tracking System (FTTS):** Identified all facilities that underwent a "Section 6 PCB Federal Inspection" under TSCA. The inspectors assessed if the facility met annual documentation requirements; complied with marking, storage, transport, and disposal regulations of PCB-containing equipment; and used PCBs under a use authorization (US EPA, 2004). The inspection may have involved sampling to prove a potential violation or to determine the extent of the potential violation (US EPA, 2004). I obtained this list from the EDR reports, which are current as of 2012, when

[7] **Generator:** User, owner, or processor of PCBs or PCB items and maintains storage facilities for PCBs; **Storer:** Commercial storage facility that accepts PCB wastes generated by others; **Transporter:** Conducts any transport of PCBs; **Research Facility:** Conducts research into PCB disposal technologies or conduct treatability studies; **Disposer:** Holds a US EPA permit to dispose of PCBs in concentrations exceeding 50 ppm; **Smelter:** Uses a scrap metal recovery oven/smelter and high efficiency boilers to dispose of PCBs (US EPA, 2008).

US EPA stopped updating the list (EDR, 2017a,b). Inspections reported in the EDR reports were conducted between 1985 and 2000.

- All previously identified facilities in other categories (namely Releases or Permitted Dischargers), remained in those categories.
- Newly identified facilities were added to the Users category, if they had no reported violations or if further research into the nature of the violation revealed that no release was likely to have occurred. The majority of the violations recorded were reporting or labeling violations.

- **US EPA's Integrated Compliance Information System (ICIS):** US EPA migrated the FTTS database to ICIS in 2007 (Hindin, 2006), and ICIS is now managed within the US EPA's Envirofacts data system. I did not identify any additional sites using the ICIS database or Envirofacts (US EPA, 2019b).
- **US EPA's Enforcement and Compliance History Online (ECHO) Database:** This database was used to identify all facilities with violations that resulted in enforcement actions under TSCA Section 6 (US EPA, 2019a). I identified three additional sites from the ECHO database.

In addition, potential additional PCB users were identified using Monsanto Customer Records and Monsanto Invoices, which were provided to me in the course of this litigation. The Monsanto Customer Records appear to be a partial listing of national customers from 1959 to 1977 (Monsanto Co., 1977a). The Monsanto Invoices are limited to customers within Washington State (Monsanto Co., 1977b). All facilities with shipping addresses within the Spokane River watershed were identified and compared to the known sites list. If facilities were not already included on the Releases or Permitted Dischargers list, then they were assumed to have no known releases or discharges from the site and were thus included in the Users category. I identified seven additional sites from the Monsanto records.

Lastly, the LimnoTech PCB reduction report (LimnoTech, 2016) was used to supplement information about utility companies and their transformers located within the Spokane River watershed. LimnoTech's estimates in the PCB reduction report are based on direct communication with the utilities. I have not identified the original source information; one additional User was identified based on this report.

Disposal: This category consists of disposal sites (*e.g.*, landfills) where PCB-containing wastes may currently be or have historically been disposed. US EPA's Approved PCB Commercial Storage and Disposal Facilities database identifies facilities that are approved under TSCA to accept and/or dispose of PCB waste (US EPA, 2018b). US EPA's PCB National Report identifies sites with scrap metal smelters or high-efficiency boilers that may be used to dispose of PCBs in the watershed (US EPA, 2017b). One site was identified from these US EPA-maintained databases.

In addition, WA Ecology and IDDEQ maintain state inventories of solid waste disposal facilities. Specific disposal locations have also been identified through research on the Release sites. For example, Pentzer WWTP biosolids was disposed of at the Mica Landfill (WA Ecology, c. 1991).

This category also includes locations where PCB-containing WWTP biosolids has been placed for agricultural use (HDR Engineering, Inc., 2009; HDR, Inc., 2010; Spokane, Washington, 2017b).

A5.3 Summary of Results of Upland PCB Site Research

Overall, 198 sites were identified from the information sources described above (Figures A5.1 and 5.2a-c). Some sites are included in two categories, such that there are:

- **Releases:** 44 sites;
- **Permitted Dischargers:** 69 sites;
- **Users:** 77 sites; and
- **Disposal:** 8 sites.

The sites identified by this research methodology, as well as the basis for their identification and categorization are described in Tables A5.3a-d and shown in Figures A5.2a-c. These tables provide a high-level summary and several organizational groupings of the information collected for each site:

- **Site Identification:** Site name, data sources used to identify the site, and site identification numbers assigned from various databases;
- **Location Information:** Geographic location, including municipality (*e.g.*, City of Spokane) and sewer basin (when applicable);
- **On-site PCB Use:** Description of the nature of PCB-related operations, whether PCBs have been detected on-site, and a description of the PCB impacts (when available);
- **Discharge Type:** Sewer basin and other discharge-related information; and
- **Permitted Discharges:** Additional information on NPDES or SIU permits, including PCB-related requirements and measurements that have been made in the effluent wastewater.

References Reviewed and Relied Upon

ADM Milling Co. 2014. "Notice of Intent, Industrial Stormwater General Permit, ADM Milling Co., 2301 E Trent Ave., Spokane, WA." Submitted to Washington State Dept. of Ecology (WA Ecology). 4p., May 13.

Agency for Toxic Substances and Disease Registry (ATSDR). 1990. "Preliminary Health Assessment for General Electric (Spokane Shop), Spokane, Washington (CERCLIS No. WAD001865450)." 15p., June 1.

Agency for Toxic Substances and Disease Registry (ATSDR). 1994. "Preliminary Public Health Assessment, Spokane Junkyard, Spokane, Spokane County, Washington (CERCLIS No. WAD981767296)." 52p., March 17.

Agency for Toxic Substances and Disease Registry (ATSDR). 1995. "Site Review and Update, General Electric Company (Spokane Shop), Spokane, Spokane County, Washington (CERCLIS No. WAD001865450)." 16p., July 14.

Agency for Toxic Substances and Disease Registry (ATSDR). 2014. "Health Consultation: Evaluation of PCBs Associated with the Former Radio Relay Station Area, Former Fort Morrow, and Other Former Use Areas, Port Heiden, Alaska." 108p., September 18.

Agency for Toxic Substances and Disease Registry (ATSDR); Washington State Dept. of Health (WADOH). 2005. "Health Consultation: BNSF Hillyard Lead Site, Spokane, Spokane County, Washington." 23p., March 11.

Agency for Toxic Substances and Disease Registry (ATSDR); Washington State Dept. of Health (WADOH). 2009. "Health Consultation: Trichloroethylene (TCE) Contaminated Groundwater, Euclid and Woods Roads Area, Spokane County, Washington." DOH 334-202. 17p., January 9.

Alaska Community Action on Toxics (ACAT). 2006. "Formerly Used Defense Sites in the Norton Sound Region: Location, History of Use, Contaminants Present, and Status of Clean-Up Efforts." 47p., July 1.

Alaska Dept. of Environmental Conservation (ADEC). 2018. "CSP Database Contaminated Sites Search." Spill Prevention and Response (SPAR). 1p. Accessed at http://dec.alaska.gov/Applications/SPAR/PublicMVC/CSP/Search.

Alta Geosciences, Inc. 1997. "Draft Completion Report, Removal Action Construction, Spokane Junkyard and Associated Properties Superfund Site, Spokane, Washington." Report to Spokane Junkyard Cleanup Committee. 126p., January.

Andresen, WD. [Inland Empire Paper Co.]. 2005. Letter to J. Roland (Washington State Dept. of Ecology) re: Comments to PCB sedimentation in the Spokane River. 3p., April 20.

Avista Corp. 2010. "Upper Falls and Nine Mile Reservoir Rainbow Trout Stocking Plan: 2010 Annual Report (License Article 405)." Report to Federal Energy Regulatory Commission (FERC). 5p., September 27.

Avista Corp.; Washington State Dept. of Fish and Wildlife (WDFW). 2013. "Revised Lake Spokane Fishery Enhancement and Creel Survey Plan (License Article 406)." Report to Federal Energy Regulatory Commission (FERC). 28p., March 15.

Barrett, G. [Washington State Dept. of Ecology (WA Ecology)]. 1997. Letter to D. Bender (Washington Water Power) re: Waukon Radio Relay Annex #2 no further action decision. 2p., March 12.

Bechtel Environmental, Inc. 1998. "GE-Spokane Remedial Design/Remedial Action Project Final Cleanup Action Report. Volume 1." Report to General Electric Co. 102p., August.

Bell, JG; McGhee, F; Dick, JR; Tocher, DR. 2005. "Dioxin and dioxin-like polychlorinated biphenyls (PCBs) in Scottish farmed salmon (*Salmo salar*): Effects of replacement of dietary marine fish oil with vegetable oils." *Aquaculture* 243(1-4):305-314. doi: 10.1016/j.aquaculture.2004.10.016.

Bellatty, JM. [Washington State Dept. of Ecology (WA Ecology), Water Quality Program]. 2011. Letter to M. Breen (Spokane International Airport) re: Temporary State Waste Discharge Permit for Spokane International Airport [Permit No. ST0045499]. 1p., November 7.

Bellatty, JM. [Washington State Dept. of Ecology (WA Ecology)]. 2016. Letter to S. Endres (Kaiser Aluminum) re: Extension of National Pollutant Discharge Elimination System (NPDES) Permit No. WA0000892. 1p., June 30.

Bosevich, A. [Spokane, Washington]. 2010a. Internal email to R. Gennett and G. Keasemeyer [re: Hollister Stier site status]. 1p., April 6. [SPOKANE-PRR-0433809]

Bosevich, A. [Spokane, Washington]. 2010b. Internal email to R. Gennett and G. Keasemeyer [re: Thermo Fluids site status]. 1p., April 6. [SPOKANE-PRR-0433809]

Budinger & Associates. 2015. "Letter Report to T. Hurley (Shamrock Paving Inc., Murphy Brothers Division) re: UST Assessment & Closure in Place, 2nd and Monroe USTs Assessment: Shamrock Paving Project - City of Spokane Monroe Street/Lincoln Street Couplet Phase 1, Spokane, WA." 76p., November 12.

California Integrated Waste Management Board. 1993. "Metallic Discards Management Plan." Publication No. 500-93-001. 21p., August.

California Military Dept. 2018. "Los Angeles Defense Area Site LA-78." California State Military Museum. Accessed at http://www.militarymuseum.org/LA78.html.

Canadian Food Inspection Agency (CFIA). 2004. "Summary Report of Contaminant Results in Fish Feed, Fish Meal and Fish Oil." January 20. Accessed at https://web.archive.org/web/20060303205752/www.inspection.gc.ca/english/anima/feebet/dioxe.shtml.

Carline, RF; Barry, OM; Ketola, HG. 2004. "Dietary uptake of polychlorinated biphenyls (PCBs) by rainbow trout." *N. Am. J. Aquaculture* 66(2):91-99. doi: 10.1577/A03-028.1.

Carter, P. [Washington State Dept. of Ecology (WA Ecology), Toxics Cleanup Program]. 2013. Letter to D. Steele (Spokane, Washington, Engineering Services Division) [re: No Further Action at Hite Crane & Rigging Inc., 4323 E. Broadway, Spokane, WA]. 3p., December 23.

Cascade Earth Sciences. 2011. "Wastewater Discharge Permit Application, Spokane International Airport." Report to Spokane International Airport (Spokane, WA) Submitted to Spokane, Washington, Wastewater Management Dept. 76p., October 27. [SPOKANE-PRR-2157848 - SPOKANE-PRR-2157923]

Cascade Earth Sciences. 2013a. "Final Recovered Deicer Land Application Pilot Project Engineering Report, Spokane International Airport." Report to Spokane International Airport. 396p., April 30.

Cascade Earth Sciences. 2013b. Technical Memorandum to Spokane International Airport and WA Ecology re: Addendum to Final Recovered Deicer Land Application Pilot Project Engineering Report. 19p., July 2.

Cascade Earth Sciences. 2013c. Technical Memorandum to D. Washington (WA Ecology) re: 2013 Stormwater Progress Report, Spokane International Airport, SWDP ST-0045499. Report to Spokane International Airport. 9p., July 17.

Cascade Earth Sciences. 2014. Technical Memorandum to D. Washington (WA Ecology) re: 2013-2014 Stormwater Progress Report, Spokane International Airport, SWDP ST-0045499. Report to Spokane International Airport. 8p., July 31.

CH2M HILL. 1994. "Spokane Industrial Park Soil and Debris Pile Independent Remedial Action Report." Report to Pentzer Development Corp. Submitted to Washington State Dept. of Ecology (WA Ecology). 55p., August 31.

CH2M HILL. 1995. "SV7 Site Independent Remedial Action Report." Report to Pentzer Development Corp. 448p., October.

CH2M HILL. 2008. "Second Five-Year Review Report for Priority One and Two Sites, Fairchild Air Force Base, Washington (Final)." Report to Air Force Center for Engineering and the Environment (AFCEE/ICM); Fairchild AFB CES/CEVR. 234p., June.

CH2M HILL. 2010. Technical Memorandum to D. Arnold (Spokane, Washington) re: Evaluation of City of Spokane Riverside Park Water Reclamation Facility Acceptance of Inland Empire Paper Wastewater (Draft). 10p., February 3. [SPOKANE-PRR-0277243 - SPOKANE-PRR-0277252]

CH2M HILL. 2014. "Integrated Clean Water Plan (Final)." Report to Spokane, Washington. 282p., December 31.

Crown West Realty, LLC. 2015a. "Spokane Business and Industrial Park - Locations." Accessed at http://www.thepark.biz/locations.html.

Crown West Realty, LLC. 2015b. "Spokane Business and Industrial Park - Availability." Accessed at http://www.thepark.biz/available.html.

Denfield, DC. 2014. "Washington Naval Depots (World War II)." February 20. Accessed at http://www.historylink.org/File/10175.

e2M Inc. 2007. "Environmental Assessment of the Privatization of Military Family Housing, Fairchild Air Force Base, Washington." Report to US Air Force, Headquarters Air Mobility Command. 222p., March 26.

Easton, MDL; Luszniak, D; Von der Geest, E. 2002. "Preliminary examination of contaminant loadings in farmed salmon, wild salmon and commercial salmon feed." *Chemosphere* 46(7):1053-1074. doi: 10.1016/S0045-6535(01)00136-9.

Ecology and Environment, Inc. (E&E). 1988. "Site Inspection Report for Spokane Junkyard and Associated Sites, Spokane, Washington." Submitted to US EPA Region X. 64p.

Ecology and Environment, Inc. (E&E). 1991. "Final On-Scene Coordinator Report for Spokane Junkyard Removal, Spokane, Washington." Submitted to US EPA Region X. 64p., September.

Ecology and Environment, Inc. (E&E). 1998. "Potentially Responsible Party Search for the Spokane Junkyard and Associated Sites, Spokane, Washington." Report to Jacobs Engineering Group Inc. 160p., August.

Economic and Engineering Services, Inc. 1999. "Spokane County Coordinated Water System Plan Update." Report to Spokane County, Washington. 137p., June 10.

EDR. 2017a. "DataMap Environmental Atlas: Spokane, WA." 6834p., March 10.

EDR. 2017b. "Idaho EDR Site Report™ binder." 256p., November 14.

Emerald Recycling Services Inc. 2013. "Scope of Work Quote [re: Transport and disposal of approximately 4500 gallons >50 ppm PCB oil and cleaning of tanks contaminated from PCB oil]." Submitted to Spokane, Washington. 1p., September 3. [SPOKANE-PRR-0473261]

Emerald Services, Inc. Dba Emerald Recycling. 2011. "Response to Request for Proposal [re: Transportation, recycling, and disposal of household used motor oil and antifreeze]." Submitted to Spokane, Washington. 129p., v. [SPOKANE-PRR-0293827 - SPOKANE-PRR-0293955]

Ennis-Flint Inc. 2014. "Paint contract usage by customer and volume."

ERM-West, Inc. 2017. "Remedial Investigation/Feasibility Study Report, BNSF Railway Black Tank Property, 3202 East Wellesley Avenue, Spokane, Washington (Draft)." Report to BNSF Railway Co.; Husky Oil Operations Limited. 361p., March.

Esvelt Environmental Engineering. 2002. "Inland Empire Paper Co., Paper Mill Discharge to the Spokane River, Polychlorinated Biphenyl (PCB) Compounds." 9p., February 18. [SPOKANE-PRR-0161535 - SPOKANE-PRR-0161543]

Esvelt Environmental Engineering. 2016. "Engineering Report: NPDES Permit (WA-0000825) Item S5, Treatment Technology Selection and Implementation to Meet Water Quality Based Effluent Limits." Report to Inland Empire Paper Co. 66p., October.

Esvelt, LA. [Esvelt Environmental Engineering]. 2005. Memorandum re: PCB contribution to sediments in the Spokane River from Inland Empire Paper Co. 14p., April 19.

EWOS Canada Ltd. 2017. "Invoice [Fish feed]." Submitted to Ford Trout Hatchery (Ford, WA) Invoice No. 6071219. 1p., December 4.

Finlay, DJ; Siff, FH; DeCarlo, VJ. 1976. "Review of PCB levels in the environment." Report to US EPA, Office of Toxic Substances. National Technical Information Service (NTIS). NTIS PB-253735; EPA 560/7-76-001. 139p., January.

FortWiki. 2018. "Othello Air Force Station." Accessed at http://fortwiki.com/Othello_Air_Force_Station.

Frame, GM; Cochran, JW; Bowadt, SS. 1996. "Complete PCB congener distributions for 17 Aroclor mixtures determined by 3 HRGC systems optimized for comprehensive, quantitative, congener-specific analysis." *J. High Resolut. Chromatogr.* 19(12):657-668.

GeoEngineers, Inc. 2007. "Cleanup Action Report, Atlas Mine and Mill Supply Site, Spokane, Washington." Report to BNSF Railway Co. Submitted to Washington State Dept. of Ecology (WA Ecology). 267p., July 20.

GeoEngineers, Inc. 2008a. "Draft Industrial Wastewater System Sampling Report, Kaiser Trentwood Facility, Spokane Valley, Washington." Report to Kaiser Aluminum Fabricated Products, LLC. 18p., October 28.

GeoEngineers, Inc. 2008b. "Environmental Site Assessment and Remedial Well Installation Report, BNSF Parkwater Rail Yard Facility, Spokane, Washington." Report to BNSF Railway Co. 195p., June 30.

GeoEngineers, Inc. 2009a. "Final Cleanup Action Report, City Parcel Site, Spokane, Washington." Report to Washington State Dept. of Ecology (WA Ecology), Eastern Regional Office. 24p., October 5.

GeoEngineers, Inc. 2009b. "Engineering Design Report, City Parcel Site, Spokane, Washington (Draft)." Report to Washington State Dept. of Ecology (WA Ecology), Toxics Cleanup Program. 31p., February 11.

GeoEngineers, Inc. 2009c. "Groundwater Monitoring Report, City Parcel Site, Spokane, Washington." Report to Washington State Dept. of Ecology (WA Ecology), Toxics Cleanup Program. 55p., January 20.

GeoEngineers, Inc. 2010. "Final Draft Remedial Investigation Report, BNSF Parkwater Rail Yard Site, Spokane, Washington." Report to BNSF Railway Co. 239p., August 11.

GeoEngineers, Inc. 2014. "Work Plan: Supplemental Remedial Investigation, City Parcel Site, Spokane, Washington." Report to Washington State Dept. of Ecology (WA Ecology). 73p., May 15.

GeoEngineers, Inc. 2016. "Supplemental Environmental Assessment, 230 Division Avenue, 24 and 28 Spokane Falls Boulevard, Spokane, Washington (Draft)." 102p., December 21.

Golder Associates Inc. 1990. "Phase 5 Remedial Action Work Plan, East 4323 Mission Avenue, Spokane, Washington." Report to General Electric Co. 62p., May 16.

Golder Associates Inc. 2013. "Second Biannual 2012 Groundwater Compliance Monitoring and Annual Data Report for General Electric Spokane, Washington Site." Report to General Electric Co. 20p., January 29.

Gravity Consulting, LLC. 2015. "2014 Spokane River Field Sampling Report, Spokane River Regional Toxics Task Force, Washington and Idaho." Report to Spokane River Regional Toxics Task Force (SRRTTF). 236p., January.

Hart Crowser, Inc. 1991. Letter Report to P. Blau (Kaiser Aluminum & Chemical Corp.) re: Interim PCB Cleanup Report, Kaiser Trentwood Works, Spokane, Washington. Submitted to Washington State Dept. of Ecology (WA Ecology). 25p., June 26.

Hart Crowser, Inc. 2008. "West Discharge Ravine Interim Action Completion Report, Kaiser Trentwood, Spokane Valley, Washington." Report to Kaiser Aluminum Fabricated Products, LLC. 39p., February 25.

Hart Crowser, Inc. 2012a. "Final Site-Wide Soil Remedial Investigation, Kaiser Trentwood Facility, Spokane Valley, Washington [Volumes I-II and Appendices A-C]." Report to Kaiser Aluminum Washington, LLC, May.

Hart Crowser, Inc. 2012b. "Final Site-Wide Groundwater Remedial Investigation, Kaiser Trentwood Facility, Spokane Valley, Washington [Volumes I-II, Plates, and Appendices A-F]." Report to Kaiser Aluminum Washington, LLC, May.

Hart Crowser, Inc. 2012c. "Final Feasibility Study Report, Kaiser Trentwood Facility, Spokane Valley, Washington [Volumes I-II and Appendices A-I]." Report to Kaiser Aluminum Washington, LLC, May.

Hart Crowser, Inc. 2012d. "Final Feasibility Technical Memorandum, Kaiser Trentwood Facility, Spokane Valley, Washington." Report to Kaiser Aluminum Washington, LLC. 641p., May.

Hart Crowser, Inc. 2012e. "Remedial Investigation Addendum, West Discharge Ravine, Kaiser Trentwood Facility, Spokane Valley, Washington." Report to Kaiser Aluminum Washington, LLC. 109p., April 3.

HDR Engineering, Inc. 2009. "Biosolids Management Plan (Final)." Report to Spokane County, Washington, Division of Utilities. 117p., September.

HDR, Inc. 2010. "2010 Wastewater Facilities Plan Amendment (Final)." Report to Spokane County, Washington, Division of Utilities. 103p., June 16.

Hilton, JW; Hodson, PV; Braun, HE; Leatherland, JL; Slinger, SL. 1983. "Contaminant accumulation and physiological response in rainbow trout (*Salmo gairdneri*) reared on naturally contaminated diets." *Can. J. Fish. Aquat. Sci.* 40(11):1987-1994. doi: 10.1139/f83-228.

Hindin, DA. [US EPA, Office of Compliance]. 2006. Internal memorandum re: Tracking Federal FIFRA, TSCA and EPCRA §313 compliance and enforcement accomplishments in the Integrated Compliance Information System (ICIS) in FY2007. 3p., September 29.

Hites, RA; Foran, JA; Carpenter, DO; Hamilton, MC; Knuth, BA; Schwager, SJ. 2004. "Global assessment of organic contaminants in farmed salmon." *Science* 303(5655):226-229. doi: 10.1126/science.1091447.

Hoyles, M. [US EPA Region X, Office of Environmental Assessment]. 2011. "NPDES Inspection Report, Ford Fish Hatchery, PO Box 70, Wellpinit, WA 99013-0070." 17p., May 3.

Idaho Administrative Code; Idaho Dept. of Environmental Quality (IDDEQ). 2019. "Rules Regulating the Idaho Pollutant Discharge Elimination System Program." IDAPA 58.01.25. 122p.

Idaho Dept. of Environmental Quality (IDDEQ). 2016. "Idaho Pollutant Discharge Elimination System (IPDES) Program." 2p., June.

Idaho Dept. of Environmental Quality (IDDEQ). 2017. "Idaho Pollutant Discharge Elimination System: Program Description (Revised)." Water Quality Division. 443p., July.

Idaho Dept. of Environmental Quality (IDDEQ). 2019. "Idaho Pollutant Discharge Elimination System Program." Accessed at https://www.deq.idaho.gov/water-quality/ipdes.

Idaho Dept. of Fish and Game (IDFG). 2013. "Fisheries Management Plan, 2013-2018: A Comprehensive Guide to Managing Idaho's Fisheries Resources." 367p.

Idaho Fish and Game. 2017. "Historical Stocking Records." Accessed at https://idfg.idaho.gov/ifwis/fishingPlanner/stocking/?region=1.

Inland Empire Paper Co. (IEP). 2015. "Inland Empire Paper Company NPDES Permit No. WA-000082-5 Permit Condition S6.A: Polychlorinated Biphenyl Source Identification Study." 60p., October 30.

Inland Empire Paper Co. (IEP). 2016. "Inland Empire Paper Company NPDES Permit No. WA-000082-5 Permit Condition S6.B: Polychlorinated Biphenyls Best Management Practices Plan Update, 2016 Report." 24p., November 1.

Inland Empire Paper Co. (IEP); Spokane Riverkeeper; The Lands Council. 2010. Letter Report to US EPA Docket re: Comments on Polychlorinated Biphenyls (PCBs); Reassessment of Use Authorizations, Federal Register Volume 75, No. 66/Wednesday April 7, 2010/Proposed Rules. EPA-HQ-OPPT-2009-0757. 10p., August 20.

International Agency for Research on Cancer (IARC). 2015. "IARC Monographs on the Evaluation of Carcinogenic Risks to Humans: Volume 107: Polychlorinated and Polybrominated Biphenyls." International Agency for Research on Cancer (Lyon, France); World Health Organization (WHO). IARC Monograph No. 107. 513p.

Isosaari, P; Kiviranta, H; Lie, O; Lundebye, AK; Ritchie, G; Vartiainen, T. 2004. "Accumulation and distribution of polychlorinated dibenzo-p-dioxin, dibenzofuran, and polychlorinated biphenyl congeners in Atlantic salmon (*Salmo salar*)." *Environ. Toxicol. Chem.* 23(7):1672-1679. doi: 10.1897/03-367.

Jacobs, MN; Covaci, A; Schepens, P. 2002. "Investigation of selected persistent organic pollutants in farmed Atlantic salmon (Salmo salar), salmon aquaculture feed, and fish oil components of the feed." *Environ. Sci. Technol.* 36(13):2797-2805. doi: 10.1021/es011287i.

Jacobs, MN; Johnston, PA; Wyatt, CL; Santillo, D; French, MC. 1997. "Organochlorine pesticide and PCB residues in pharmaceutical, industrial and food grade fish oils." *Int. J. Environ. Pollut.* 8(1-2):74-93. doi: 10.1504/IJEP.1997.028159.

Johnson, LL; Willis, ML; Olson, OP; Pearce, RW; Sloan, CA; Ylitalo, GM. 2010. "Contaminant concentrations in juvenile fall chinook salmon from Columbia River hatcheries." *N. Am. J. Aquac.* 72(1):73-92. doi: 10.1577/A08-068.1.

JRB Associates. 1985. "Installation Restoration Program Phase I - Records Search, 92nd Bombardment Wing (Heavy), Fairchild AFB, Washington (Draft)." Report to US Air Force, Strategic Air Command. 189p., January.

Kaiser Aluminum & Chemical Corp. 1955a. "Trentwood...today." *Kaiser Aluminum News* 3p., August.

Kaiser Aluminum & Chemical Corp. 1955b. "Two new mills roll as Trentwood's $1,500,000 expansion completed." *Kaiser Aluminum News* 2p., March.

Kaiser Aluminum & Chemical Corp. 1956a. "A decade of progress..." *Kaiser Aluminum News* 21p., September.

Kaiser Aluminum & Chemical Corp. 1956b. "Northwest roundup: KA Washington plants reach peaks in expansion, employment." *Kaiser Aluminum News* 1p., March.

Kaiser Aluminum & Chemical Corp. 1957. "Additions to existing facilities [Trentwood]." *Kaiser Aluminum News* 8p., January.

Kaiser Aluminum & Chemical Corp. 1984. "Kaiser Aluminum & Chemical Corporation 1983 Annual Report." 40p., February 24.

Kaiser Aluminum & Chemical Corp. 1986. "Kaiser Aluminum & Chemical Corporation 1985 Annual Report." 44p., March 19.

Kaiser Aluminum & Chemical Corp. 1987. "Kaiser Aluminum & Chemical Corporation 1986 Annual Report." 44p., March 10.

Kaiser Aluminum Corp. 1997. "Kaiser Aluminum Corporation 1996 Annual Report." 54p., February 28.

Kaiser Aluminum Corp. 2001. "Kaiser Aluminum Corporation 2000 Annual Report." 68p., April 2.

Kaiser Aluminum Corp. 2006. "Form 10-K: Annual Report Pursuant to Section 13 or 15(d) of the Securities Exchange Act of 1934 for the fiscal year ended December 31, 2005 re: Kaiser Aluminum Corporation." Submitted to US Securities and Exchange Commission. 165p.

Kaiser Aluminum Corp. 2017. "Form 10-Q (Quarterly Report), Filed 04/21/17 for the Period Ending 03/31/17." Submitted to US Securities and Exchange Commission. 65p.

Karl, H; Lehmann, I; Oetjen, K. 1998. "Levels of chlordane compounds in fish muscle, -meal, -oil and -feed." *Chemosphere* 36(13):2819-2832. doi: 10.1016/S0045-6535(97)10224-7.

Keithly, J; Patmont, C. [Anchor QEA]. 2011. Memorandum to B. Dowling (WA Ecology) re: Final Year 4 Upriver Dam Cap Monitoring Results. 636p., October 2.

King County, Washington. 2016. "A Review of Select PCB Source Tracing Programs." Dept. of Natural Resources and Parks, Water and Land Resources Division. Report to Washington State Dept. of Ecology (WA Ecology). 170p., July.

Krapas, DP. [Inland Empire Paper Co.]. 2016. Letter to P. Hallinan (Washington State Dept. of Ecology) re: Inland Empire Paper Company NPDES Permit No. WA 000082-5 renewal. 46p., April 29.

Lambert Group, Inc. 2001. Draft Letter Report to J. Barrier re: Limited Investigation Report of Suspect PCB-containing Soils, Property Broadway & Cook with address 2616 East Broadway, Spokane, WA. 14p., January 2. [SPOKANE-PRR-0412531 - SPOKANE-PRR-0412544]

Landau Associates, Inc. 1994. "Independent Remedial Action RMPS Site, Spokane Industrial Park, Spokane, Washington." Report to Pentzer Development Corp. 473p., January 27.

Landau Associates, Inc. 2012. "Statement of Qualifications [re: Aviation/Seaport Environmental Site Management Support Services, Port of Seattle/RFQ No. 00317324-12]." 31p., August 22.

Law Engineering Testing Co. (LETC). 1986. "Final Report: Investigation of Former Nike Missile Sites for Potential Toxic and Hazardous Waste Contamination. Volume I." LES-Government Services Division. Report to US Army Corps of Engineers, Huntsville Division. 198p., March.

LimnoTech. 2015a. "Spokane River Regional Toxics Task Force Phase 2 Technical Activities Report (Draft)." Report to Spokane River Regional Toxics Task Force (SRRTTF). 36p., May 20.

LimnoTech. 2015b. "Spokane River Regional Toxics Task Force Phase 2 Technical Activities Report: Identification of Potential Unmonitored Dry Weather Sources of PCBs to the Spokane River." Report to Spokane River Regional Toxics Task Force (SRRTTF). 62p., August 12.

LimnoTech. 2016. "2016 Comprehensive Plan to Reduce Polychlorinated Biphenyls (PCBs) in the Spokane River." Report to Spokane River Regional Toxics Task Force. 125p., November 29.

LimnoTech. 2017. Memorandum to Spokane River Regional Toxics Task Force re: "Review Draft: Homolog-specific PCB Mass Balance for the Spokane River." 22p., August 16.

Little, M. 2006. "Industrial evolution." *Spokesman-Review* April 2. Accessed at http://www.spokesman.com/stories/2006/apr/02/industrial-evolution.

Mac, MJ; Nicholson, LW; McCauley, CA. 1979. "PCBs and DDE in commercial fish feeds." *Progressive Fish-Culturist* 41(4):210-211. doi: 10.1577/1548-8659(1979)41[210:PADICF]2.0.CO;2.

Maule, AG; Gannam, AL; Davis, JW. 2007. "Chemical contaminants in fish feeds used in federal salmonid hatcheries in the USA." *Chemosphere* 67(7):1308-1315. doi: 10.1016/j.chemosphere.2006.11.029.

MGS Environmental, Inc. 2004. "Subsurface Investigation for Soil Contamination at the Proposed City of Spokane Fuel and Wash Facility Site Located at 2616 East Broadway Avenue, Spokane, Washington (Final Field Report)." Report to Spokane, Washington, Dept. of Public Works and Utilities. 37p., December 13. [SPOKANE-PRR-0412448 - SPOKANE-PRR-0412484]

Monsanto Co. 1977a. "Product/customer sales records (1959-1977)." 439p. [WATER_PCB-00042358 - WATER_PCB-00042796]

Monsanto Co. 1977b. "Washington invoices binder (1966-1977)." 717p. [WATER_PCB-00038835 - WATER_PCB-00039551]

Montana Dept. of Environmental Quality (MTDEQ). 2005. "Big Spring Creek Watershed Water Quality Restoration Plan and Total Maximum Daily Loads (Version 1.1)." 294p., March. Accessed at https://deq.mt.gov/Portals/112/water/wqpb/CWAIC/TMDL/M22-TMDL-01a.pdf.

Moore, B. [Washington State Dept. of Ecology (WA Ecology)]. 2014. Letter to K. Paine (ADM Milling Co.) re: Reissuance of coverage under the Industrial Stormwater General Permit, Centennial Mills, Div. ADM Milling, 2301 E Trent Ave., Spokane, WA [Permit No. WAR000313]. 3p., December 3.

Myriad Systems & Services, Inc. 1990. "Final Baseline Report, Spokane Transformer Site, Spokane, Washington." Report to US EPA. 61p., March 21.

Needles, A. 2017. "A look inside the privately-owned egg incubation facility in Bonney Lake." July 31. *News Tribune*. Accessed at http://www.thenewstribune.com/news/local/community/puyallup-herald/ph-news/article163733768.html.

Nine Mile Falls Campground. 2013. "Summary Score Sheet: Nine Mile Falls Campground, 11800 W Charles Rd, Nine Mile Falls, WA." 6p.

Noe, AE. [General Electric Co.]. 1987. Letter to C. Heisler (Centennial Mills) re: Final PCB material disposal [Waste manifests, General Electric Tracking No. 20967/Shop No. 40031; General Electric Document No. 87010/AR-097256]. 4p., September 8.

Northeast Public Development Authority Board (NEPDA); Spokane, Washington. 2017. "The Yard Redevelopment Master Plan." 95p., April 10.

Northwest Area Committee. 2017. "Lake Pend Oreille and Pend Oreille River Geographic Response Plan." 488p.

Opalski, DD. [US EPA Region X]. 2006. Letter to D. Rosen (US Army Corps of Engineers, Seattle District) re: Euclid Road Ground Water Site, Fairchild Nike Battery 87 - Formerly Used Defense Site, Spokane County, Washington. 4p., October 11.

Parsons. 2007. "Spokane River PCB TMDL Stormwater Loading Analysis (Final Technical Report)." Report to US EPA Region X; Washington State Dept. of Ecology (WA Ecology) Publication No. 07-03-055. 52p., December.

Pentzer Development Corp. 1992. Letter Report to D. George (WA Ecology) re: Model Toxics Control Act - Release Report [Spokane Industrial Park]. 21p., March 3.

Permanente Metals Corp. 1947a. "Aluminum." *Permanente News* 5p., January.

Permanente Metals Corp. 1947b. "Trentwood probes massacre." *Permanente News* 2p., October.

PTI Environmental Services. 1995. "Former Wastewater Treatment Plant Remedial Activities Report." Report to Pentzer Development Corp. 89p., September.

Ream, J. 1964. "Kaiser plants in Spokane prepare to boost output." *Spokesman-Review* 1p., October 25.

Roar Tech Environmental Services Inc. Undated. "Report [re: Completion of the permanent closure of an eight thousand gallon (8,000) gasoline underground storage tank (UST) for Spokane County]." Report to Spokane, Washington. 53p. [SPOKANE-PRR-1718330 - SPOKANE-PRR-1718382]

Rumsey, GL. 1980. "Adventitious toxins in feeds." In *Fish Feed Technology: Lectures Presented at the FAO/UNDP Training Course in Fish Feed Technology, held at the College of Fisheries, University of Washington, Seattle, Washington, U.S.A., 9 October-15 December 1978*. United Nations Development Programme, Food and Agriculture Organization of the United Nations. p183-186.

Schwyn Environmental Services. 2015. "Letter Report to P. Leinart (WA Ecology) re: Site Discovery and Release Report for 24 and 28 East Spokane Falls Boulevard, Spokane, Washington." 89p., December 4.

Science Applications International Corp. (SAIC). 2002a. "Final Remedial Investigation Work Plan, City Parcel Site, Spokane, Washington." Report to Washington State Dept. of Ecology (WA Ecology), Eastern Regional Office. 63p., February 1.

Science Applications International Corp. (SAIC). 2002b. "Remedial Investigation Report for the City Parcel Site, Spokane, Washington (Draft)." Report to Washington State Dept. of Ecology (WA Ecology), Eastern Regional Office. 164p., October 7.

Science Applications International Corp. (SAIC). 2003. "Final Report of Wastewater and Sludge Sampling at Inland Empire Paper Company, Spokane, Washington (Revision 1)." Report to Washington State Dept. of Ecology (WA Ecology). 74p., April 4.

Scott, C. 2012. "Trentwood gets major upgrades." *Spokane J. Bus.* 2p., March 29.

Skeo Solutions. 2012. "Fourth Five-Year Review Report for Northside Landfill (WAD980511778), Spokane, Spokane County, Washington." Report to US EPA Region X. 81p., September 23.

Spokane County, Washington. 2017. "Parcel Boundary GIS File, Spokane County, WA."

Spokane County, Washington, Public Works Dept. (SCPWD). 2015. "NPDES Permit Renewal Application, Spokane County Regional Water Reclamation Facility (Permit No. WA-0093317)." Submitted to Washington State Dept. of Ecology (WA Ecology). Utilities Division. 81p., October 1.

Spokane River Regional Toxics Task Force (SRRTTF). 2015. Project Completion Memo to A. Borgias, *et al.* re: Assessment of PCBs in Spokane Valley Groundwater. Environmental Assessment Program. 20p., September 16.

Spokane River Regional Toxics Task Force (SRRTTF). 2016. "Spokane Regional Toxics Task Force August 24, 2016 (Revised final draft) [Summary meeting notes]." 7p., September 28.

Spokane, Washington, Wastewater Management Dept. (SWWM). 2012a. "Fact Sheet - City of Spokane Wastewater Discharge Permit SIU-4581-01, Fairchild Airforce Base." 46p.

Spokane, Washington, Wastewater Management Dept. (SWWM). 2012b. "Fact Sheet - City of Spokane Water Discharge Permit SIU-XXXX-01, Spokane International Airport (Draft)." 26p., January 23. [SPOKANE-PRR-0172502 - SPOKANE-PRR-0172527]

Spokane, Washington, Wastewater Management Dept. (SWWM). 2013a. "2013 Annual Report: Adaptive Management Plan for Reducing PCBs in Stormwater Discharges (Reporting Period: May, 2012 to May, 2013)." 52p., June.

Spokane, Washington, Wastewater Management Dept. (SWWM). 2013b. "2012 Pretreatment Annual Report." 30p., March 4. [SPOKANE-PRR-0749901 - SPOKANE-PRR-0749930]

Spokane, Washington, Wastewater Management Dept. (SWWM). 2014. "2014 Annual Report: Adaptive Management Plan for Reducing PCBs in Stormwater Discharges (Reporting Period: May, 2013 to May, 2014)." 53p., June.

Spokane, Washington, Wastewater Management Dept. (SWWM). 2015a. "NPDES Permit Renewal Application, Riverside Park Water Reclamation Facility (Permit No. WA-002447-3)." Submitted to Washington State Dept. of Ecology (WA Ecology). 76p., December 21. [SPOKANE-PRR-0209062 - SPOKANE-PRR-0209137]

Spokane, Washington, Wastewater Management Dept. (SWWM). 2015b. "City of Spokane Stormwater Management Program (SWMP). 2014." Permit No. WAR04-6505. 48p.

Spokane, Washington, Wastewater Management Dept. (SWWM). 2015c. "PCBs in Municipal Products (Revised)." 45p., July 21.

Spokane, Washington. 2011. "Documentation [re: Award of Transportation, Recycling, and Disposal of Household Used Motor Oil and Antifreeze contract to Oil Re-Refining Co., Inc. (ORRCO)]." Solid Waste Management Dept. 41p. [SPOKANE-PRR-2407283 - SPOKANE-PRR-2407323]

Spokane, Washington. 2016a. "Evaluation of Polychlorinated Biphenyls in Deicer (Draft)." Environmental Programs. 24p., May 11. [SPOKANE-PRR-1539318 - SPOKANE-PRR-1539341]

Spokane, Washington. 2016b. "Evaluation of Polychlorinated Biphenyls in Traffic Marking Paint." Environmental Programs. 15p., December 6. [SPOKANE-PRR-2231596 - SPOKANE-PRR-2231610]

Spokane, Washington. 2017a. "Plaintiff's responses and objections to Solutia Inc.'s special interrogatories [Set One] [re: City of Spokane *v*. Monsanto Co., *et al*.]." Submitted to US District Court, Eastern District of Washington. 19p., July 27.

Spokane, Washington. 2017b. "Riverside Park Water Reclamation Facility." Public Works and Utilities. Accessed at https://my.spokanecity.org/publicworks/wastewater/treatment-plant.

Spokane, Washington; Able Clean-Up Technologies, Inc. 2007. "Contract for cleanup and disposal of PCB-contaminated soil at 4701 East Valley Springs Road, Spokane, Washington." 5p., July 12. [SPOKANE-PRR-3306909 - SPOKANE-PRR-3306913]

Spokane International Airport (SIA). 2012. "Application for a State Waste Discharge Permit to Discharge Industrial Wastewater to Ground Water by Land Treatment or Application." Submitted to Washington State Dept. of Ecology (WA Ecology). 144p. [SPOKANE-PRR-0780937 - SPOKANE-PRR-0781076]

Spokane International Airport (SIA). 2013. "Application for a State Waste Discharge Permit to Discharge Industrial Wastewater to Ground Water by Land Treatment or Application (Revised)." Submitted to Washington State Dept. of Ecology (WA Ecology). 248p., July.

Spokane Tribe of Indians. 2007. "Spokane Tribal Hatchery Operation and Maintenance: Annual Report, January - December 2007." Report to US Dept. of Energy, Bonneville Power Administration, Division of Wildlife. 19p.

Spokane Tribe of Indians. 2017. "Spokane Tribal Hatchery." Dept. of Natural Resources. Accessed at http://www.spokanetribe.com/dnr-hatchery.

Spokane Tribal Fisheries. 2018. "Spokane Tribal Hatchery." Accessed at http://spokanetribalfisheries.com/programs/spokane-tribal-hatchery.

Spokane Valley Herald. 1976. "Kaiser to invest heavily at Trentwood plant." *Spokane Valley Herald* 1p., December 8.

Spokane Valley, Washington. 2012. "Meeting agenda and associated documentation [re: May 8, 2012 meeting regarding Proposed Ordinance 12-014: Comprehensive Plan Amendments (includes text and map amendments)]." 208p.

Spokesman Review. 1942. "Developments on the aluminum front." *Spokesman-Review* 2p., October 25.

Targeted Community and Brownfields. c. 2014. "Targeted Community and Brownfields: Hillyard, Spokane, WA." 19p.

Therien, NC. [Washington State Dept. of Ecology (WA Ecology)]. 1985. Letter to B. York (General Electric Co.) [re: Inspection of the Former General Electric Spokane Apparatus Service Shop]. 8p., December 7.

US Air Force. 1977. "NPDES Permit Application, Fairchild Air Force Base, Spokane, Washington." Headquarters 92nd Combat Support Group (SCA). Submitted to US EPA Region X. 3p., October 7.

US Air Force. 1980. "Headquarters 92D Combat Support Group (SAC) Application for Hazardous Waste Permit." Submitted to US EPA Region X. 44p., November 18.

US Air Force. 2013. "Third Five-Year Review Report for Fairchild AFB, Washington (Final)." 247p., August.

US Army Construction Engineering Research Laboratories (US ACERL). 1997. "Searching the Skies: The Legacy of the United States Cold War Defense Radar Program." Report to US Air Force Air Combat Command. 202p., June.

US Army Corps of Engineers (US ACE); Kennedy-Tudor Consulting Engineers. 1976. "Metropolitan Spokane Region Water Resources Study. Appendix H, Volume 1: Plan Formulation and Evaluation." US ACE Seattle District. NTIS ADA036595. 463p.

US Army Corps of Engineers (US ACE). 2015a. "Formerly Used Defense Sites (FUDS) Public Geographic Information System (GIS) - 2015 Annual Report to Congress [Washington State FUDS Properties]." 1p.

US Army Corps of Engineers (US ACE). 2015b. "Formerly Used Defense Sites (FUDS) [Washington State]." 6p., September 30.

US Census Bureau. 2015. "TIGER/Line® shapefiles and TIGER/Line® files." Accessed at https://www.census.gov/geo/maps-data/data/tiger-line.html.

US Census Bureau. 2016a. "US County Boundaries."

US Census Bureau. 2016b. "US State Boundaries."

US District Court, Eastern District of Washington. 2011. "Consent decree between Plaintiff Spokane Riverkeeper and Defendant City of Spokane [re: Spokane Riverkeeper v. City of Spokane]." Case No. CV-11-0217-LRS. 47p., August 23.

US Dept. of Transportation (US DOT). 2012. "National Policy: Polychlorinated Biphenyls (PCBs) in the National Airspace System." Federal Aviation Administration (FAA). Order 1050.14B. 23p., November 6.

US EPA Region VII. 1979. "Kansas PCB Contaminated Cattle and Swine." 135p.

US EPA. 1991. "PCB, Lead, and Cadmium Levels in Shredder Waste Materials: A Pilot Study (Final)." Office of Toxic Substances, Office of Solid Waste. EPA 560/5-90-008B. 474p., April.

US EPA. 1992a. "Enforcement Accomplishments Report, FY 1991." Office of Enforcement, Compliance Evaluation Branch. 300-R92-008; LE-133. 156p., April.

US EPA. 1992b. "Pollution Prevention through Compliance and Enforcement: A Review of OPTS Accomplishments." Office of Pesticides and Toxic Substances. 22T-1002. 60p., January.

US EPA. 1993. "Superfund Record of Decision: Fairchild Air Force Base 4 Areas (Operable Unit 2), WA." EPA/ROD/R10-93/068. 191p., July.

US EPA. 1996. "Record of Decision: Fairchild Air Force Base (4 Waste Areas), Operable Unit 1, Spokane WA." EPA/ROD/R10-96/136. 251p.

US EPA. 1999a. "PCB case seeks $700,000 in fines for illegal disposal near Spokane." 5p., February 3. [SPOKANE-PRR-1557022 - SPOKANE-PRR-1557026]

US EPA. 1999b. "Order on motions [re: The Burlington Northern and Santa Fe Railway Co.]." Office of Administrative Law Judges. Docket No. TSCA-10-99-0051, November 23. Accessed at http://widit.knu.ac.kr/epa/ebtpages/Compliance_n_Enforcement/Civil_Enforcement/Orders/siteout/s1out89.htm.

US EPA. 2004. "Polychlorinated Biphenyl Inspection Manual." Office of Compliance. EPA-305-X-04-002. 346p., August. Accessed at https://www.epa.gov/sites/production/files/2013-09/documents/pcbinspectmanual.pdf.

US EPA. 2008. "Item-by-Item Instructions for Completing EPA Form 7710-53." Office of Solid Waste. 1p., March.

US EPA. 2009. "PCB Waste Handlers Database results [re: Washington State facilities]." 17p., September 1. [SPOKANE-PRR-0081613 - SPOKANE-PRR-0081629]

US EPA. 2010. "PCB Waste Handlers Database results [re: US EPA Region X facilities]." 26p., February 25. [SPOKANE-PRR-0711080 - SPOKANE-PRR-0711105]

US EPA. 2011. "PCB Waste Handlers Database results [re: US EPA Region X facilities]." 354p., October 21. [SPOKANE-PRR-1599488 - SPOKANE-PRR-1599841]

US EPA. 2015a. "Most Recent" EPA Regulated PCB Transformer Data." Office of Pollution Prevention and Toxics. 324p., October. Accessed at https://www.epa.gov/sites/production/files/2015-10/documents/most_recent_registrations_excel_document.xls_.pdf.

US EPA. 2015b. "PCBs in Building Materials - Questions & Answers." Office of Solid Waste and Emergency Response (OSWER), Office of Resource Conservation and Recovery. 18p., July 28 Accessed at https://www.epa.gov/sites/production/files/2016-03/documents/pcbs_in_building_materials_questions_and_answers.pdf.

US EPA. 2015c. "Facility Registry Service (FRS) record for General Electric Co., 3919 N Sullivan Rd., Spokane, WA, 99216-1605 (EPA Registry Id: 110005311457)." September 24.

US EPA. 2016. "Revision of certain federal water quality criteria applicable to Washington." *Fed. Reg.* 81(228):85417-85437. 40 CFR 131. November 28.

US EPA. 2017a. "Discharge Monitoring Report (DMR) Pollutant Loading Tool."

US EPA. 2017b. "PCB Waste Handlers Database results [re: All United States facilities]." 4452p., January 18.

US EPA. 2017c. "USGS Discharge Monitoring Report (DMR) Site Locations, Spokane and Upper Columbia River Watersheds (WA and ID)." In *Enforcement and Compliance History Online (ECHO) Water Pollutant Loading Tool: Water Pollution Search*. Office of Enforcement and Compliance Assurance. Accessed at https://echo.epa.gov/trends/loading-tool/water-pollution-search.

US EPA. 2018a. "Idaho NPDES Permits [Database]." Accessed at https://www.epa.gov/npdes-permits/idaho-npdes-permits.

US EPA. 2018b. "List of Approved Polychlorinated Biphenyl (PCB) Commercial Storage and Disposal Facilities." Accessed at https://www.epa.gov/pcbs/list-approved-polychlorinated-biphenyl-pcb-commercial-storage-and-disposal-facilities.

US EPA. 2018c. "Superfund Site Information Search Results for Radio Relay Sites." Accessed at https://cumulis.epa.gov/supercpad/CurSites/srchsites.cfm.

US EPA. 2019a. "Enforcement and Compliance History Online (ECHO)." Accessed at https://echo.epa.gov.

US EPA. 2019b. "Permit Compliance System (PCS) and Integrated Compliance Information System (ICIS): PCS-ICIS Overview." Accessed at https://www.epa.gov/enviro/pcs-icis-overview.

US EPA Region X. 2002a. "Superfund Fact Sheet: Northside Landfill, Spokane, Washington." 4p., November.

US EPA Region X. 2002b. "Second Five-Year Review Report for Northside Landfill Superfund Site, Spokane, Spokane County, Washington." 56p., September 30.

US EPA Region X. 2006a. "June 2006 Update on EPA activities in the Deep Creek area, West Spokane County." 4p., June.

US EPA Region X. 2006b. "Fact Sheet [re: Proposals to issue three general wastewater discharge permits, two of them for aquaculture facilities in Idaho, one of them for fish processors associated with aquaculture facilities in Idaho and an individual permit for Epicenter Aquaculture]." NPDES Permit No. IDG-130000; NPDES Permit No. IDG-131000; NPDES Permit No. IDG-132000; NPDES Permit No. ID-002826-6. 134p., June 14.

US EPA Region X. 2006c. "Five-Year Review, Spokane Junkyard and Associated Properties Superfund Site, Spokane, Washington (Excerpts)." 12p., September 29.

US EPA Region X. 2007. "Authorization to Discharge under the National Pollutant Discharge Elimination System (NPDES): Aquaculture Facilities in Idaho, subject to Wasteload Allocations under Selected Total Maximum Daily Loads." Permit No.: IDG-130000. 96p., October 25.

US EPA Region X. 2011. "Five-Year Review, Spokane Junkyard and Associated Properties Superfund Site, Spokane, Washington." 16p., September 23.

US EPA Region X. 2014a. "National Pollutant Discharge Elimination System (NPDES) Program State Authorization Guidance (Draft)." Office of Water and Watersheds, NPDES Permits Unit. 69p., March.

US EPA Region X. 2014b. "Authorization to Discharge Under the National Pollutant Discharge Elimination System: Hayden Area Regional Sewer Board, 10789 North Atlas Road, Hayden, ID (Final)." Permit No.: ID0026590. 42p., September 30.

US EPA Region X. 2015. "Fact Sheet: Washington Hatchery General Permit." NPDES Permit Number: WAG130000. 91p., December 23.

US EPA Region X. 2016. "Authorization to Discharge under the National Pollutant Discharge Elimination System (NPDES): Federal Aquaculture Facilities and Aquaculture Facilities Located in Indian Country." Permit No. WAG13000. 106p., June 9.

US EPA Region X; US Army Corps of Engineers (US ACE). 2007. "Third Five-Year Review Report for Northside Landfill Superfund Site, Spokane, Spokane County, Washington." 110p., September.

US Fish and Wildlife Service Region I. 2012. "Investigation of Contaminants in Feeds and Fish at FWS Pacific Region National Fish Hatcheries and the Ramifications to Human and Ecological Health (Final)." 94p., August.

US Food and Drug Administration (US FDA). 2017. "Unavoidable contaminants in food for human consumption and food-packaging material, Subpart B - Tolerances for unavoidable poisonous or deleterious substances: Polychlorinated biphenyls (PCBs)." 21 CFR 109.30. 3p.

US Geological Survey (USGS). 2018. "USGS stream gauge locations for the Spokane River, Washington." In *National Water Information System Web Interface: USGS Water Data for the Nation*. Accessed at https://waterdata.usgs.gov/usa/nwis.

US Government Accountability Office (US GAO). 2002. "Environmental Contamination: Corps Needs to Reassess Its Determinations That Many Former Defense Sites Do Not Need Cleanup." GAO-02-658. 84p., August 23.

US War Assets Administration. 1947. "Aluminum Plants and Facilities: First Supplemental Report of the War Assets Administration to the Congress." 55p., February 12.

Washington State Dept. of Ecology (WA Ecology). 1984. "Potential Hazardous Waste Site Preliminary Assessment Summary Memorandum re: General Electric Co. (Spokane Apparatus Service Shop), E. 4323 Mission Avenue, Spokane, WA." 10p., September 7.

Washington State Dept. of Ecology (WA Ecology). 1992a. "Spokane Industrial Park Class II Inspection, May 18-20, 1992." 93-e27. 43p., March.

Washington State Dept. of Ecology (WA Ecology). 1992b. "National Pollutant Discharge Elimination System Waste Discharge Permit No. WA 000095-7, Spokane Industrial Park, N. 3808 Sullivan Road, Spokane, WA." 21p., April 20.

Washington State Dept. of Ecology (WA Ecology). 1993. "Final Cleanup Action Plan, Former General Electric Spokane Shop, E. 4323 Mission Avenue, Spokane, WA." Toxics Cleanup Program. 44p., March 29.

Washington State Dept. of Ecology (WA Ecology). 1995. "Department of Ecology 1993-94 Investigation of PCBs in the Spokane River." Publication No. 95-310. 88p., February.

Washington State Dept. of Ecology (WA Ecology). 1995-2015. "Notes from Calls and Emails with USFWS, Avista, Spokane Tribe." 79p.

Washington State Dept. of Ecology (WA Ecology). 1996. "Spokane River PCB Source Monitoring Follow-up Study, November and December 1995." Publication No. 96-331. 32p., July.

Washington State Dept. of Ecology (WA Ecology). 2001. "Spokane River PCB and Source Survey, August 2000." Publication No. 01-03-016. 35p., April.

Washington State Dept. of Ecology (WA Ecology). 2002. "Spokane Area Point Source PCB Survey, May 2001." Publication No. 02-03-009. 94p., March.

Washington State Dept. of Ecology (WA Ecology). 2003a. "Periodic Review, General Electric/Spokane Site, 1997-2002." 30p., March 20.

Washington State Dept. of Ecology (WA Ecology). 2003b. "Compliance Report re: Burlington Northern Santa Fe RR-Parkwater (RCRA ID #: WAD 9980835425)." Hazardous Waste & Toxics Reduction Program. 20p., August 15.

Washington State Dept. of Ecology (WA Ecology). 2004a. "Final Cleanup Action Plan, City Parcel Site, Spokane, Washington." Eastern Regional Office, Toxics Cleanup Program. 166p., August.

Washington State Dept. of Ecology (WA Ecology). 2004b "Draft Cleanup Action Plan, City Parcel Site, Spokane, Washington." Eastern Regional Office, Toxics Cleanup Program. 68p., July.

Washington State Dept. of Ecology (WA Ecology). 2004c "Table 740-1 Method A: Soil Cleanup Levels for Unrestricted Land Uses." WAC 173-340-900. 2p.

Washington State Dept. of Ecology (WA Ecology). 2005a. "Amended order [In the matter of compliance by Kaiser Aluminum and Chemical Corporation Trentwood Works]." Amended Order No. 2868. 5p., October 12.

Washington State Dept. of Ecology (WA Ecology). 2005b. "Site Register excerpt [re: Voluntary Cleanup Program no further action decision, General Electric, 3919 N Sullivan Rd., Spokane, WA]." Toxics Cleanup Program. 6p., May 19.

Washington State Dept. of Ecology (WA Ecology). 2006. "Persistent Organic Pollutants in Feed and Rainbow Trout from Selected Trout Hatcheries." Environmental Assessment Program. Publication No. 06-03-017. 52p., April.

Washington State Dept. of Ecology (WA Ecology). 2008. "Second Periodic Review, General Electric Spokane Site, Spokane, WA." 34p., April.

Washington State Dept. of Ecology (WA Ecology). 2009. "What does it mean to be on Ecology's List of 'Contaminated' Sites?" Toxics Cleanup Program. 2p., April. Accessed at https://www.ofm.wa.gov/sites/default/files/public/legacy/resources/yearend/What_does_it_mean_to_be_on_Ecologys_list.pdf.

Washington State Dept. of Ecology (WA Ecology). 2010a. "Fact Sheet for Wastewater Discharge Permit No. SIU-3471-03, Facility Name: Lloyd Industries, Inc. (Draft)." 19p.

Washington State Dept. of Ecology (WA Ecology). 2010b. "BNSF Parkwater Railyard Site [Fact sheet]." Toxics Cleanup Program. 6p., September.

Washington State Dept. of Ecology (WA Ecology). 2010c. "Periodic Review, Inland Empire Paper, 3320 North Argonne Road, Millwood, Washington 99212." 16p., August.

Washington State Dept. of Ecology (WA Ecology). 2011a. "National Pollutant Discharge Elimination System Waste Discharge Permit No. WA-000082-5, Inland Empire Paper Company, 3320 N. Argonne Road, Spokane, WA." 39p., November 1.

Washington State Dept. of Ecology (WA Ecology). 2011b. "National Pollutant Discharge Elimination System Waste Discharge Permit No. WA-000089-2, Kaiser Aluminum Fabricated Products, LLC, 15000 E Euclid Ave, Spokane Valley, WA." 43p., June 23.

Washington State Dept. of Ecology (WA Ecology). 2011c. "Spokane River PCB Source Assessment, 2003-2007." Publication No. 11-03-013. 156p., April.

Washington State Dept. of Ecology (WA Ecology). 2011d. "Spokane International Airport: Attachment A, Temporary Permit No. ST0045499." Water Quality Program. 7p., November 7.

Washington State Dept. of Ecology (WA Ecology). 2011e. "Draft Cleanup Action Plan, BNSF Parkwater Railyard, Spokane, WA." Toxics Cleanup Program. 46p., September.

Washington State Dept. of Ecology (WA Ecology). 2012a. "Spokane River Water Quality Improvement Projects: Spokane River PCBs Project." December.

Washington State Dept. of Ecology (WA Ecology). 2012b. "Kaiser Trentwood Site Update." Toxics Cleanup Program. 4p., August.

Washington State Dept. of Ecology (WA Ecology). 2012c. "Spokane River Urban Waters Source Investigation and Data Analysis Progress Report (2009-2011): Source Tracing for PCB, PBDE, Dioxin/Furan, Lead, Cadmium, and Zinc." Publication No. 12-04-025. 92p., September.

Washington State Dept. of Ecology (WA Ecology). 2013a. "Third Periodic Review (Draft Final), General Electric Spokane Site." 60p., March.

Washington State Dept. of Ecology (WA Ecology). 2013b. "2nd Periodic Review, WA CC Spokane Community College, Maintenance Building 201, 2000 N. Greene Street, Spokane, Washington." 19p., June.

Washington State Dept. of Ecology (WA Ecology). 2014a. "Eastern Washington Phase II Municipal Stormwater Permit." 62p., August 1.

Washington State Dept. of Ecology (WA Ecology). 2014b. "National Pollutant Discharge Elimination System Waste Discharge Permit No. WA0000892, Kaiser Aluminum Fabricated Products, LLC, 15000 E Euclid Ave, Spokane Valley, WA [Modified]." 37p., November 18.

Washington State Dept. of Ecology (WA Ecology). 2014c. "Appleway Chevrolet, Inc. Site [Fact sheet]." Toxics Cleanup Program. 3p., March.

Washington State Dept. of Ecology (WA Ecology). 2015a. "National Pollutant Discharge Elimination System (NPDES) and State Waste Discharge General Permit for Stormwater Discharges Associated with Industrial Activities: Industrial Stormwater General Permit." 69p., January 2.

Washington State Dept. of Ecology (WA Ecology). 2015b. "Fact Sheet: Upland Fin-Fish Hatching and Rearing NPDES General Permit." 86p., December 16.

Washington State Dept. of Ecology (WA Ecology). 2015c. "Second Periodic Review, Martin Wood Products Property, 2105 North Airport Street, Spokane, Washington." 21p., January.

Washington State Dept. of Ecology (WA Ecology). 2015d. "Periodic Review: Spokane River Upriver Dam and Donkey Island PCB Sediment Site." 24p., December.

Washington State Dept. of Ecology (WA Ecology). 2016a. "Fact Sheet for NPDES Permit WA0000892, Kaiser Aluminum Washington, LLC (Draft)." 71p., June 30.

Washington State Dept. of Ecology (WA Ecology). 2016b. "National Pollutant Discharge Elimination System Waste Discharge Permit No. WA0000892, Kaiser Aluminum Fabricated Products, LLC, 15000 E Euclid Ave, Spokane Valley, WA (Draft)." 57p., June 30.

Washington State Dept. of Ecology (WA Ecology). 2016c. "Second Periodic Review, Inland Empire Paper, 3320 North Argonne Road, Millwood, Washington 99212." 18p., April.

Washington State Dept. of Ecology (WA Ecology). 2016d. "Quality Assurance Project Plan: Spokane and Troutlodge Fish Hatchery PCB Evaluation." Publication No. 16-03-104. 45p., March.

Washington State Dept. of Ecology (WA Ecology). 2016e. "National Pollutant Discharge Elimination System (NPDES) and State Waste Discharge General Permit: Upland Fin-Fish Hatching and Rearing." 49p., April 1.

Washington State Dept. of Ecology (WA Ecology). 2016f. "Administrative order [In the matter of the WDFW Spokane Hatchery]." Docket No. 13422. 8p., July 1.

Washington State Dept. of Ecology (WA Ecology). 2016g. "Wastewater Treatment Facility Site Visit Report, Spokane International Airport Deicing." 3p., April 12.

Washington State Dept. of Ecology (WA Ecology). 2016h. "Polychlorinated Biphenyls in Consumer Products." Publication No. 16-04-014. 61p., November.

Washington State Dept. of Ecology (WA Ecology). 2016i. "Spokane River Regional Toxics Task Force, Evaluation of Measureable Progress, Evaluation Period: January 1, 2012 – December 31, 2014 (Final)." 43p., March 15.

Washington State Dept. of Ecology (WA Ecology). 2016j. "Periodic Review, Columbia Paint & Coatings, 112 North Haven Street, Spokane, WA." 23p., January.

Washington State Dept. of Ecology (WA Ecology). 2017a. "Cleanup site search details." Toxics Cleanup Program.

Washington State Dept. of Ecology (WA Ecology). 2017b. "Confirmed and suspected contaminated sites data." Toxics Cleanup Program.

Washington State Dept. of Ecology (WA Ecology). 2017c. "Cleanup Site Search."

Washington State Dept. of Ecology (WA Ecology). 2017d. "Environmental Information Management (EIM) database."

Washington State Dept. of Ecology (WA Ecology). 2017e. "National Pollutant Discharge Elimination System (NPDES) and State Waste Discharge General Permit for Stormwater Discharges Associated with Construction Activity: Construction Stormwater General Permit." 55p., May 5.

Washington State Dept. of Ecology (WA Ecology). 2017f. "Rivers and Watersheds (Washington State)."

Washington State Dept. of Ecology (WA Ecology). 2017g. "Dams (Washington State)."

Washington State Dept. of Ecology (WA Ecology). 2017h. "Tribal Lands (Washington State)."

Washington State Dept. of Ecology (WA Ecology). 2017i. "Underground Injection Control (UIC) Database (Version 2.1.0)." Underground Injection Control Program.

Washington State Dept. of Ecology (WA Ecology). 2017j. "Site Information: City Parcel Site, 708 N Cook St, Spokane, WA."

Washington State Dept. of Ecology (WA Ecology). 2017k. "Cleanup Site Details: FUDS Fairchild Nike 45." 1p., July 20.

Washington State Dept. of Ecology (WA Ecology). 2017l. "Cleanup Site Details: Schade Brewery." 2p., July 24.

Washington State Dept. of Ecology (WA Ecology). 2017m. "Cleanup Site Details: BNSF Parkwater Railyard." Toxics Cleanup Program. 2p., June 26.

Washington State Dept. of Ecology (WA Ecology). 2017n. "Cleanup Site Details: BNSF Hillyard Lead Soil Site." Toxics Cleanup Program. 2p., June 1.

Washington State Dept. of Ecology (WA Ecology). 2017o. "Water Quality Permitting and Reporting System (PARIS)."

Washington State Dept. of Ecology (WA Ecology). 2017p. "Cleanup Site Details: Spokane International Airport." 2p., June 20.

Washington State Dept. of Ecology (WA Ecology). 2017q. "Cleanup Site Details: Avista Corp Beacon Storage Yard." Toxics Cleanup Program. 1p., May 12.

Washington State Dept. of Ecology (WA Ecology). 2017r. "Cleanup Site Details: Barrier Trust Property." Toxics Cleanup Program. 2p., June 18.

Washington State Dept. of Ecology (WA Ecology). 2017s. "Cleanup Site Details: Alaska Steel & Supply." Toxics Cleanup Program. 1p., June 18.

Washington State Dept. of Ecology (WA Ecology). 2017t. "Cleanup Site Details: General Electric Co. Spokane." 2p., June 27.

Washington State Dept. of Ecology (WA Ecology). 2017u. "Cleanup Site Details: Mica Peak Federal Aviation Agency, US FAA Mice Peak." 1p., July 20.

Washington State Dept. of Ecology (WA Ecology). 2017v. "Cleanup Site Details: Appleway Chevrolet Inc." Toxics Cleanup Program. 2p., June 26.

Washington State Dept. of Ecology (WA Ecology). 2017w. "Cleanup Site Details: Atlas Mine & Mill Supply Inc." Toxics Cleanup Program. 2p., June 2.

Washington State Dept. of Ecology (WA Ecology). 2017x. "Cleanup Site Details: Stockland Livestock Exchange." 2p., June 27.

Washington State Dept. of Ecology (WA Ecology). 2017y. "Cleanup Site Details: FUDS Fairchild Nike 87." 2p., July 20.

Washington State Dept. of Ecology (WA Ecology). 2017z. "Cleanup Site Details: Avista Corp. Spokane Service Center." 2p., June 22.

Washington State Dept. of Ecology (WA Ecology). 2017aa. "Cleanup Site Details: Spokane River Upriver Dam and Donkey Island." 2p., July 20.

Washington State Dept. of Ecology (WA Ecology). 2018a. "Water Quality Permitting and Reporting System (PARIS)."

Washington State Dept. of Ecology (WA Ecology). 2018b. "Reissuance of Eastern Washington Phase II Municipal Stormwater Permit: Initial Overview of the Proposed Permit Language Changes for the 2019 Permit." 2p., April 9.

Washington State Dept. of Ecology (WA Ecology). 2018c. "National Pollutant Discharge Elimination System and State Waste Discharge General Permit for Process Water, Stormwater, and Mine Dewatering Water Discharges Associated with Sand and Gravel Operations, Rock Quarries, and Similar Mining Facilities, Including Stockpiles of Mined Materials, Concrete Batch Operations and Hot Mix Asphalt Operations: The Sand and Gravel General Permit." 64p., April 1.

Washington State Dept. of Ecology (WA Ecology). 2018d. "Cleanup Site Details: US DOE BPA Bell Maintenance HQ." 2p., April 20.

Washington State Dept. of Ecology (WA Ecology). 2018e. "Cleanup Site Details: FUDS RRA 3 Dartford." 1p., May 1.

Washington State Dept. of Ecology (WA Ecology). 2018f. "Cleanup Site Details: FUDS RRA 7 Davenport." 1p., May 1.

Washington State Dept. of Ecology (WA Ecology). 2019. "Eastern Washington Phase II Municipal Stormwater Permit." 57p., July 1.

Washington State Dept. of Ecology (WA Ecology). c. 1991. "Fact Sheet - Application for National Pollutant Discharge Elimination System (NPDES) Permit to Discharge Pollutants to State Waters [Renewal of Permit WA-000095-7]." 36p.

Washington State Dept. of Ecology (WA Ecology). c. 1999. "Summary scoring sheets, City Parcel, 708 N. Cooke, Spokane, WA 99202." 8p.

Washington State Dept. of Ecology (WA Ecology). c. 2018. "Facility/Site: Circle M Construction Co Inc." 2p.

Washington State Dept. of Ecology (WA Ecology); Kaiser Aluminum & Chemical Corp. 2005. "Agreed order [In the matter of remedial action by Kaiser Aluminum and Chemical Corporation Trentwood Site]." Agreed Order No. 2692. 102p., June 6.

Washington State Dept. of Ecology (WA Ecology); Kaiser Aluminum Washington, LLC. c. 2012. "Amendment No. 1 to agreed order [In the matter of remedial action by Kaiser Aluminum & Chemical Corporation Trentwood Site]." Agreed Order No. 2692. 29p.

Washington State Dept. of Ecology (WA Ecology); Washington State Dept. of Health (WADOH). 2015. "PCB Chemical Action Plan." Publication No. 15-07-002. 223p., February.

Washington State Dept. of Ecology (WA Ecology); US EPA. 2011. "Near Marmots, Near Beer: A Tour of Cleanup & Redevelopment Projects in Downtown Spokane." Presented at Brownfields & Land Revitalization 2011 Conference: Turning Liabilities into Assets in the Inland Northwest. 8p.

Washington State Dept. of Fish and Wildlife (WDFW). 2008. "Ford Hatchery Annual Report, January 1, 2007 - December 31, 2007." Report to US Dept. of Energy, Bonneville Power Administration, Division of Wildlife. 12p., January.

Washington State Dept. of Fish and Wildlife (WDFW). 2015a. "NPDES Permit Renewal Application, Permit No. WAG13-7007." Submitted to Washington State Dept. of Ecology (WA Ecology). 10p., January 21.

Washington State Dept. of Fish and Wildlife (WDFW). 2015b. "Spokane Hatchery." 2p., March. Accessed at http://srrttf.org/wp-content/uploads/2015/03/Spokane-Fact-Sheet.pdf.

Washington State Dept. of Fish and Wildlife (WDFW). 2015c. "WDFW Plans - Facility Sampling, Solid Waste Management, Pollution Prevention, Spokane Hatchery - WAG 13-7007." 14p., January 15.

Washington State Dept. of Fish and Wildlife (WDFW). 2017a. "2017 Statewide Hatchery Trout & Kokanee Stocking Plan for Washington's Lakes and Streams." Accessed at https://wdfw.wa.gov/publications/01900/wdfw01900.pdf.

Washington State Dept. of Fish and Wildlife (WDFW). 2017b. "Spokane Hatchery Paint and Caulk Assessment Report and Feed Plan." Report to Washington State Dept. of Ecology (WA Ecology). 2p., February 28.

Washington State Dept. of Fish and Wildlife (WDFW). 2017c. "WDFW Spokane Hatchery - Review of Status of Administrative Order Docket No. 13422." Submitted to Washington State Dept. of Ecology (WA Ecology). 4p., December 8.

Washington State Dept. of Fish and Wildlife (WDFW). 2018a. "Trout Stocking: Statewide Hatchery Trout & Kokanee Stocking Plan." Accessed at https://wdfw.wa.gov/fishing/plants/statewide.

Washington State Dept. of Fish and Wildlife (WDFW). 2018b. "Catchable Trout Plant Reports."

Washington State Dept. of Fish and Wildlife (WDFW). 2018c. "About the Washington Department of Fish & Wildlife." Accessed at https://wdfw.wa.gov/about.

Washington State Dept. of Transportation (WSDOT). 1996. "Southriver Drive, City of Spokane, Division Street to Perry Street: Limited, Environmental Assessment Report of Known and Suspected Contaminated Sites." Eastern Region Environmental Office. 20p., February. [SPOKANE-PRR-1737307 - SPOKANE-PRR-1737326]

Washington Superior Court, Spokane County. 2003. "Consent decree between Washington State Department of Ecology, Avista Development, Inc., and Kaiser Aluminum & Chemical Corporation [re: State of Washington, Dept. of Ecology *v*. Avista Development, Inc., and Kaiser Aluminum & Chemical Corp.]." No. 03-2-00422-1. 120p., February 5.

Washington Superior Court, Spokane County. 2012. "Consent decree between Washington State Department of Ecology and BNSF Railway Company [re: State of Washington, Dept. of Ecology *v*. BNSF Railway Co.]." 109p., April 18.

White, J Jr. [Spokane Riverkeeper]. 2015. Email to B. Adams (Liberty Lake Sewer and Water District), et al. [re: Stocked fish migration]. 2p., September 4.

Wilkinson, T. 2015. "Making things right again." *Mont. Outdoors* p30-34. Accessed at http://fwp.mt.gov/mtoutdoors/pdf/2015/LewistownHatchery.pdf.

Windsor, S. [Spokane, Washington]. 2013. Internal email to G. Glenn and K. Gimpel [re: City of Tacoma settles with EPA for violating federal rules on PCBs in used oil]. 2p., October 1. [SPOKANE-PRR-0473717 - SPOKANE-PRR-0473718]

Wnek, Z. 2018. "Schade Brewery." Accessed at http://www.spokanehistorical.org/items/show/152.

Tables

Table A5.1 Information Sources Used to Identify PCB Sites

Source Author	Source Title	Description	Site List Outcome	Category
EDR (2017a)	DataMap Environmental Atlas	EDR provides comprehensive searches of available state and federal databases to produce compilations of environmental-related information about sites in given areas. An "EDR DataMap Environmental Atlas" was generated for the Spokane and Liberty Lake areas of Washington.	21 additional sites were identified using the EDR report based on their presence on PCB-related lists (the National PCB Notifications or PCB Transformer Registry).	Identified potential Users, Permitted Dischargers, and Releases.
EDR (2017b)	DataMap Environmental Atlas	A limited data report was generated for the Idaho cities located along the Spokane River.	Additional sites were identified using the EDR report based on their presence on PCB-related lists (the National PCB Notifications or PCB Transformer Registry).	Identified potential Users, Permitted Dischargers, and Releases.
LimnoTech (2016)	PCB Reduction Report	The LimnoTech report includes estimates of PCB-containing transformers in the Spokane River watershed based on direct conversation with the utilities. We have not identified the original source information, and therefore rely on this report for the identification of additional Users.	Three additional utilities were identified. Further information was obtained about five utilities.	Identified potential Users.
Monsanto Co. (1977a,b)	Monsanto Customer Records and Monsanto Invoices	The Monsanto Customer Records appear to be a partial listing of national customers from 1959 to 1977. The Monsanto Invoices are limited to customers within Washington State. Sites not already included in the Releases or Permitted Dischargers category were included in the Users category.		
Spokane County, Public Works Department (SCPWD, 2015); Spokane Wastewater Management Department (SWWM, 2015a)	SIU Permitting	SIU permit holders were identified by reviewing current and past NPDES permits from the Riverside Park Water Reclamation Facility (Riverside WWTP) and the Spokane County Regional Water Reclamation Facility (SCRWRF).	Overall, 31 facilities were identified, 25 of which were not previously identified.	New sites were included as Permitted Dischargers.
SRRTTF (2015)	Assessment of PCBs in Spokane Valley Groundwater	The Task Force and WA Ecology's Environmental Assessment Program (EAP) identified sites where PCBs may be present in groundwater and possibly contribute PCBs to the river.	Of the 33 sites, 25 were identified on WA Ecology's Cleanup Site Details list (described above). The additional 8 sites were identified by the EAP, but the rationale was not usually provided.	All sites identified are included in the Releases category.
US EPA (2009, 2010, 2011, 2017b)	PCB National Report	US EPA maintains a list of sites that are known to have a PCB activity. Also known as the Notifications for PCB Activities (PADS).	28 facilities in Spokane County and 1 in Idaho search. Six sites have known PCB releases, three are known permitted dischargers, and the remaining sites are included as User sites.	New sites were included as Users.
US EPA (2019a)	US EPA's Enforcement and Compliance History Online (ECHO)	US EPA maintains the ECHO database to track compliance and enforcement information nationwide. ECHO searches the Integrated Compliance Information System (ICIS), which includes actions taken under TSCA.	Three additional sites identified.	Identified two potential Users and one potential Release.
US EPA (2015a)	Regulated Transformers	US EPA requires that transformers with over 500 ppm of PCBs present in the transformer oils are required to be registered; additional transformers with lower concentrations may also be included.	Three companies with registered transformers were identified in Spokane County, none in Kootenai County.	New sites were included as Users.

Source Author	Source Title	Description	Site List Outcome	Category
US EPA (2017a)	Discharge Monitoring Report (DMR) Pollutant Loading Tool	US EPA maintains the complete list of National Pollutant Discharge Elimination System (NPDES) permitted discharges on this site. The site also includes sampling information when available. WA Ecology is the regulatory entity issuing most of the NPDES permits in Washington, US EPA is the regulatory entity currently in Idaho and permits on tribal lands are administered by US EPA.	205 permits were identified in the Spokane River watershed. The list was then restricted to (a) permits related to water treatment plants; (b) permits related to municipal separated storm sewer systems; and (c) any site-specific permit in which PCBs are regulated in some way.	Overall 31 NPDES permits were identified for the Permitted Dischargers category. Only one site was previously identified as a Release site (Kaiser).
US EPA (2018a)	Idaho NPDES Permits (Database)	US EPA maintains a database that includes information about current and inactive permits issued in Idaho.	No additional sites identified, obtained further information on known sites.	N/A
US EPA (2018b)	Approved PCB Commercial Storage and Disposal Facilities	US EPA permitted facilities that store PCB waste prior to proper disposal.	No storage or disposal facilities were identified in the Spokane River watershed located within Washington or Idaho.	None.
US EPA (as cited in EDR, 2017a,b)	FIFRA and TSCA Tracking System (FTTS)	US EPA tracks enforcement actions and compliance activities for FIFRA, TSCA, and EPCRA. EDR has info from 1985-2012; US EPA online database only includes violations over the past 3 years, of which there are some not associated with PCBs. Identified all sites that underwent a "Section 6 PCB Federal Inspection."	Searched *via* the EDR report. No additional inspections or actions found on US EPA online database.	Identified potential Users.
US EPA (as cited in EDR, 2017a,b)	TSCA Database	US EPA maintains a list of the manufacturers and importers of chemical substances included on the TSCA Chemical Substance Inventory list (which includes PCBs). US EPA last issued this list in 2012.	Searched *via* the EDR report.	Identified potential Users.
WA Ecology (1995, 2001, 2002)	Point Source Surveys	WA Ecology conducted PCB point source surveys in 1993-1994, 2000, and 2001 to identify potential major contributors to the Spokane River.	The early studies focused on Kaiser Trentwood, the Spokane Industrial Park, three wastewater treatment plants (Spokane, Liberty Lake and Post Falls), the Old Inland Metals Site and the Washington Water Power Co. (WWP, now Avista Corp.) Beacon Storage Yard. Inland Empire Paper Company was added to their study in 2001.	All of the industrial locations were included on either the WA Ecology Cleanup Site list or Task Force groundwater memo and are included in our Releases category. The WWTPs were included under the Permitted Dischargers category.
WA Ecology (2017a)	Cleanup Site Details	List includes information about potential contamination for a wide range of chemicals of concern (COCs) in environmental media; relative concentrations of the COCs in each media are described by six levels.	30 sites within the Washington portion of the Spokane River watershed were identified with PCB contamination in at least one media on-site; additional sites with halogenated organic contamination were also reviewed, including several Formerly Used Defense Sites (FUDS) sites.	All sites with suspected or confirmed PCB contamination are included in the Releases category.
WA Ecology (2017b)	Confirmed and Suspected Contaminated Sites List (CSCSL)	Provides additional details on active sites found in the Cleanup Site Details list.	No additional sites identified, obtained further information on known sites.	N/A
WA Ecology (2017c)	Cleanup Site Search website	WA Ecology maintains additional information for some sites. This publically available information includes brief site background information, and may also include legal documents and technical reports such as feasibility studies, remedial investigations, and periodic reviews.	No additional sites identified; obtained further information on known sites.	N/A

Source Author	Source Title	Description	Site List Outcome	Category
WA Ecology (2017d)	Environmental Information Management (EIM) Database	For each of the Release sites identified, we obtained the PCB sampling data from the EIM database in order to assess the potential magnitude of PCB releases to the watershed for these sites.	No additional sites identified, obtained further information on known sites.	N/A
WA Ecology (2018a)	Permitting and Reporting Information System (PARIS) database	WA Ecology maintains a water quality database that includes information about current and inactive permits. Information provided may include submissions from the permittee, enforcement actions, and inspection reports.	No additional sites identified, obtained further information on known sites.	N/A

Notes:

EPCRA = Emergency Planning and Community Right-to-Know Act; FIFRA = Federal Insecticide, Fungicide, and Rodenticide Act; N/A = Not Applicable; PCB = Polychlorinated Biphenyl; ppm = Parts Per Million; SIU = Significant Industrial User; Task Force = Spokane River Regional Toxics Task Force; TSCA = Toxic Substances Control Act; US EPA = United States Environmental Protection Agency; WA Ecology = Washington State Department of Ecology; WWTP = Wastewater Treatment Plant.

Table A5.3a Results of Upland PCB Site Research – Releases

Site Details				Location					On-site PCB Use		Discharges				Permitted Discharges			
Map ID	Site Name	Address	Information Source	WA Ecology Facility Site ID (FS ID)	WA Ecology Cleanup Site ID (CS ID)	City	County	Within Spokane City Limits?	Nature of PCB-related Operations	PCBs On-site?	Discharge Type	Discharge Detail	Waterbody/ Sewershed	Additional Discharges	Permit Type	Number	With PCB Information?	Notes
R3	Avista Corp. - Beacon Storage Yard	4323 E. Upriver Drive	Task Force groundwater memo; WA Ecology cleanup website search	9766365	2727	Spokane	Spokane	Yes			Other	Outside of area	Spokane River		N/A	N/A	N/A	N/A
R19	Barrier Trust Property	2616 E. Broadway Avenue	Task Force groundwater memo; WA Ecology cleanup website search	7617080	467	Spokane	Spokane	Yes	Impacts from City Parcel, which is located to the west of property, across an alleyway. City of Spokane had covered the alleyway with gravel to prevent exposure to soils impacted by PCBs.	Yes	Sewer	MS4	Union	Drywell located near southwest corner of City Parcel was disconnected from the storm system in December 2011 due to this area being a continued source of PCBs to the system.	N/A	N/A	N/A	N/A
R48	BNSF Hillyard Lead Soil Site	5000 N. Ferrall Street	Task Force groundwater memo; WA Ecology cleanup website search	960924	1371	Spokane	Spokane	Yes	The site used to have PCB-containing transformers in contact with unpaved ground surface. The BNSF Black Tank site contained a tank used to store dust oil that contained PCBs. The adjacent Freya Street site housed four PCB-containing transformers.	Yes	Sewer	MS4	Cochran		N/A	N/A	N/A	N/A
R10	BNSF Parkwater Railyard	5302 E. Trent Avenue	Task Force groundwater memo; WA Ecology cleanup website search	676	1318	Spokane	Spokane	Yes	PCBs detected in three areas: Western Fruit Express (WFE) Maintenance Facility, Transformer Storage Area, and the Dismantling Spur Area, where impacted soils were stored. One transformer containing 6.8 mg/kg PCBs present on-site in 2003.	Yes	Other	Injection and Infiltration (I&I)	N/A		N/A	N/A	N/A	N/A
R130	Spokane City Engineering	2nd Avenue & Monroe Street	Task Force groundwater memo; WA Ecology cleanup website search	22914	12963	Spokane	Spokane	Yes	Petroleum-gasoline and non-halogenated organics are present at this site.	Yes					N/A	N/A	N/A	N/A
R69	24-28 E. Spokane Falls Boulevard	24-28 E. Spokane Falls Boulevard	Task Force groundwater memo; WA Ecology cleanup website search	8544	12975	Spokane	Spokane	Yes		Yes					N/A	N/A	N/A	N/A
R25	Hite Crane & Rigging Inc.	4323 E. Broadway	Task Force groundwater memo; WA Ecology cleanup website search	1881495	12253	Spokane	Spokane	Yes	Unknown	Yes					N/A	N/A	N/A	N/A
R131	Avista N. Elizabeth St.	2425 N. Elizabeth Road	WA Ecology cleanup website search	12731	13063	Spokane Valley	Spokane	No	Unknown	Yes								
R23	Columbia Paint & Coatings	112 N. Haven Street	Task Force groundwater memo; WA Ecology cleanup website search	640	1209	Spokane	Spokane	Yes	Paint manufacturing	No	Sewer	CSO	CSO 34 (Erie)		N/A	N/A	N/A	N/A
R123	Custer Commercial Center Soil Remediation	5025 E. Sprague Avenue	Task Force groundwater memo	9889	11621	Spokane Valley	Spokane	No	None known	No	Other	Outside of area			N/A	N/A	N/A	N/A
R12	Alaska Steel & Supply	3410 E. Desmete Avenue	Task Force groundwater memo; WA Ecology cleanup website search	670	1138	Spokane	Spokane	Yes	Information not found	Yes	Sewer	MS4	Union		N/A	N/A	N/A	N/A
R97	General Electric Co. - Sullivan Road	3919 N. Sullivan Road	Task Force groundwater memo; WA Ecology cleanup website search; Monsanto Customer Records; Monsanto Invoices	34795691	2733	Spokane Valley	Spokane	No	Unknown	Yes	Other	Outside of area			N/A	N/A	N/A	N/A

Site Details				Location					On-site PCB Use		Discharges				Permitted Discharges			
Map ID	Site Name	Address	Information Source	WA Ecology Facility Site ID (FS ID)	WA Ecology Cleanup Site ID (CS ID)	City	County	Within Spokane City Limits?	Nature of PCB-related Operations	PCBs On-site?	Discharge Type	Discharge Detail	Waterbody/ Sewershed	Additional Discharges	Permit Type	Number	With PCB Information?	Notes
R9	General Electric Co.'s Spokane Apparatus Service Shop	4323 E. Mission Avenue	Task Force groundwater memo; WA Ecology cleanup website search; Monsanto Customer Records; Monsanto Invoices	630	1082	Spokane	Spokane	Yes	Transformer refurbishing facility from 1961 to 1980. Extensive use of transformer oils on-site. Uncontrolled release of oils into soils/groundwater from steam cleaning activities.	Yes	Other	Injection and Infiltration (I&I)	Infiltration area		N/A	N/A	N/A	N/A
R92	Holcim Inc.	12207 E. Empire Avenue	Task Force groundwater memo	52126416	4580	Spokane Valley	Spokane	No	None known	No	Other	Outside of area			N/A	N/A	N/A	N/A
R66	Hutton Settlement, Qwest Communications Inc. W00864	521 E. Sprague Avenue	Task Force groundwater memo	19213533		Spokane	Spokane	Yes	None	No	Sewer	CSO	CSO 26 (7th Street)		N/A	N/A	N/A	N/A
R67	Inland Metals Inc.	534 E. Spokane Falls Boulevard	Task Force groundwater memo; WA Ecology cleanup website search	669	1808	Spokane	Spokane	Yes	The Inland Metals site was a scrap metals salvaging operation until 1986.	Yes	Other	Injection and Infiltration (I&I)	1306500ND		N/A	N/A	N/A	N/A
R174	FUDS RRA 6 Trentwood	N/A	WA Ecology cleanup website search	30346918	2327	Trentwood	Spokane	No	US EPA's Superfund database includes 28 archived radio relay sites and 1 active site. 27 are located in Alaska. Alaska's list of Contaminated Sites includes 7 Cold War-era USAF radio relay sites. PCB impacts were confirmed at 4 out of the 7 sites and suspected at a fifth. Most PCB impacts arose from transformers and related equipment. Also, not all PCB-containing equipment was removed from radio relay sites after deactivation (ATSDR, 2014).	Not evaluated		Unknown			None			
R175	US FAA Mica Peak	Mica Peak	WA Ecology cleanup website search	126	2276	Spokane	Spokane	No	Closed uses. Transformers and capacitors associated with both USAF and FAA equipment. During the late 1950s-1960s, at least 600 gallons of waste oils were disposed of outside the building in the septic drainfield or dumped on the ground surface around the building. PCB concentrations are unknown.	Yes	Other	Outside of area			N/A	N/A	N/A	N/A

Site Details				Location					On-site PCB Use		Discharges				Permitted Discharges			
Map ID	Site Name	Address	Information Source	WA Ecology Facility Site ID (FS ID)	WA Ecology Cleanup Site ID (CS ID)	City	County	Within Spokane City Limits?	Nature of PCB-related Operations	PCBs On-site?	Discharge Type	Discharge Detail	Waterbody/ Sewershed	Additional Discharges	Permit Type	Number	With PCB Information?	Notes
R95	Kaiser Trentwood Facility	15000 E. Euclid Avenue	Task Force groundwater memo	81484342	4681	Spokane Valley	Spokane	No	PCB-containing hydraulic oil (Aroclors 1242/1248) used in hydraulic cylinders. PCB-containing hydraulic oil was stored in USTs in the Oil House and Tank Farm area.	Yes	Permitted discharge	Site system	Spokane River	Sanitary, industrial, and stormwater all flows through the industrial WWTP before discharge.	NPDES	WA0000892; 3 outfalls	Yes	Biweekly sampling for PCBs; monthly discharge monitoring reports. Maximum allowed PCB concentration into black walnut shell filtration system (final treatment prior to discharge into river) = 0.78 g/day Maximum daily flow = 11.0 MGD Proposed PCB limits in discharge to river: 170 ppt (average monthly); 129 mg/day (average monthly); 145 mg/day (maximum daily) Total PCB concentrations in effluent to river from July 2011 through November 2015 averaged 2,261 ppt (n = 108 samples; 4,730 ppt maximum concentration)
R5	Martin Wood Products	2105 N. Airport Street	Task Force groundwater memo	64145388	3011	Spokane	Spokane	Yes		Yes	Other	Injection and Infiltration (I&I)			N/A	N/A	N/A	N/A
R87	Martins Auto Service	9125 E. Trent Avenue	Task Force groundwater memo; WA Ecology cleanup website site search	74521817	4348	Millwood	Spokane	Yes	Unknown	Yes	Other	Outside of area	Spokane River		N/A	N/A	N/A	N/A
R8	Med Star Hanger	6400 E. Rutter Avenue	Task Force groundwater memo; WA Ecology cleanup website site search	84283894	3389	Spokane	Spokane	Yes		Yes	Other	Injection and Infiltration (I&I)			N/A	N/A	N/A	N/A
R94	Appleway Chevrolet Inc.	8500 E. Sprague Avenue	Task Force groundwater memo; WA Ecology cleanup website site search	28314355	356	Spokane Valley	Spokane	No	No information found	Yes	Other	Outside of area			N/A	N/A	N/A	N/A
R37	Nine Mile Falls Campground	11800 W. Charles Road	Task Force groundwater memo	21329	3181	Nine Mile Falls	Spokane	No	Unknown	Yes	Other	Outside of area			N/A	N/A	N/A	N/A
R544	BNSF 6401 N. Freya Street	N. 6401 Freya Street	EDR - FTTS; ECHO database	N/A	N/A	Spokane	Spokane	Yes	Four PCB-containing transformers stored on-site.	Yes					N/A	N/A	N/A	N/A
R100	Pentzer Wastewater Treatment Plant	Sullivan Road	Task Force groundwater memo; WA Ecology cleanup website site search	15442	12077	Spokane Valley	Spokane	No	Unknown source	Yes	Permitted discharge	Site system	Spokane River	Original WWTP for sanitary only; this one operated from 1971-1993 to include industrial waste.	NPDES (until 1993)	WA-000095-7	No	Stopped operation in 1993. Discharged treated wastewater directly to the Spokane River at RM 87 through a single port diffuser.
R68	Schade Brewery	528 E. Trent Avenue	Task Force groundwater memo; WA Ecology cleanup website site search	6724162	4643	Spokane	Spokane	Yes	Schade Brewery was sold to Inland Metals in 1959, and the site was used as a warehouse until 1977. Railroad operations may have also contributed in the northern portion of the site.	Yes	Other	Injection and Infiltration (I&I)			N/A	N/A	N/A	N/A
R2	Spokane Fire Department Training Facility	1618 N. Rebecca Street	Task Force groundwater memo; WA Ecology cleanup website site search	674	1225	Spokane	Spokane	Yes	Groundwater impacts are due to the neighboring GE site. One monitoring well located north of the GE site (towards river) on this site.	Yes	Other	Injection and Infiltration (I&I)			N/A	N/A	N/A	N/A

Site Details				Location					On-site PCB Use		Discharges				Permitted Discharges			
Map ID	**Site Name**	**Address**	**Information Source**	**WA Ecology Facility Site ID (FS ID)**	**WA Ecology Cleanup Site ID (CS ID)**	**City**	**County**	**Within Spokane City Limits?**	**Nature of PCB-related Operations**	**PCBs On-site?**	**Discharge Type**	**Discharge Detail**	**Waterbody/ Sewershed**	**Additional Discharges**	**Permit Type**	**Number**	**With PCB Information?**	**Notes**
R101	Spokane Industrial Park	3808 N. Sullivan Road	Task Force groundwater memo; WA Ecology cleanup website site search	814	1298	Spokane Valley	Spokane	No	One vacant lot had detectable PCB in soil. PCBs found in previous WWTP sludge and current wastewater stream. Prior to development into the Spokane Industrial Park, the area was a Naval Supply Depot.	Yes	Permitted discharge	SIU?	Riverside	Original WWTP for sanitary only; new plant operated from 1971-1993 to include industrial waste. Starting in 1993, connected to City of Spokane system with discharge to Riverside WWTP. Not listed in current NPDES for the city.	SIU?	WA-000095-7	Occasional information	Not listed as SIU in NPDES permit. 1993 information confirmed connection.
R50	Spokane Junkyard/ Associated Properties	3322 N. Cook Street	Task Force groundwater memo; WA Ecology cleanup website search; US EPA Superfund website	125	2875	Spokane	Spokane	Yes	Drained transformers onto ground (transformer casings from power plants were cracked to obtain copper inside).	Yes	Sewer	MS4	Cochran					
R51	Spokane Metals Co.	3601 Regal Street	WA Ecology cleanup website search	125	2875	Spokane	Spokane	Yes	Stored PCB-containing transformers on-site. Stripped transformers for copper. Drained PCB-containing transformer oil onto the ground. Scrap materials were from multiple sources, including Kaiser Aluminum and Washington Water Power, *etc.* Operations from 1936 to 1983.	Yes	Sewer	MS4	Cochran		N/A	N/A	N/A	N/A
R127	Spokane River Upriver Dam & Donkey Island	No address on file (WA Ecology description). The dam is located along Upriver Drive east of Greene Street. Donkey Island is east of the dam in wetlands and backwater channels on the north bank of the river.	Task Force groundwater memo; WA Ecology cleanup website site search	65178472	4213	Spokane	Spokane	Yes	Known PCB sources to the dam area of the river include: Spokane Industrial Park, the Kaiser Trentwood Works, Liberty Lake Sewage Treatment Plant, the Inland Empire Paper Company.	Yes	N/A	N/A	Spokane River		N/A	N/A	N/A	N/A
R18	Spokane Transformer, Inc./City Parcel, Inc.	708 N. Cook Street	Task Force groundwater memo; WA Ecology cleanup website search; Monsanto Invoices; Monsanto Customer Records	650	1023	Spokane	Spokane	Yes	Extensive use for refurbishing transformers. Disposal by selling, burning in furnace Spills with oil adsorbent and into municipal trash.	Yes	Sewer	MS4	Union	Drywell located near southwest corner of City Parcel was disconnected from storm system in December 2011 due to this area being a continued source of PCBs to the system.	N/A	N/A	N/A	N/A
R15	Atlas Mine and Mill Supply Inc.	1115 N. Havana Street	Task Force groundwater memo; WA Ecology cleanup website site search	56816995	1059	Spokane	Spokane	Yes	PCB transformers on-site.	Yes	Sewer	CSO	CSO 34 (Erie)		N/A	N/A	N/A	N/A
R14	Stockland Livestock Exchange	1004 N. Freya Street	Task Force groundwater memo; WA Ecology cleanup website site search	1677578	195	Spokane	Spokane	Yes	Not found	Yes	Other	Injection and Infiltration (I&I)			N/A	N/A	N/A	N/A
R39	US DOE Bonneville Power Administration Bell Maintenance HQ	2400 E. Hawthorne Road	US EPA PCB Transformers List; LimnoTech PCB reduction report	654	1270	Mead	Spokane	No	Utility: PCB transformers on-site.	Yes	Other	Outside of area			N/A	N/A	N/A	N/A
R1	WA CC Spokane Community College	2000 N. Green Street	Task Force groundwater memo; WA Ecology cleanup website site search	684	4958	Spokane	Spokane	Yes	The drywell was used as a vehicle washing rack. In October 1990, the drywell became plugged and over 1,200 gallons of waste were pumped and disposed of.	Unknown	Other	Injection and Infiltration (I&I)			N/A	N/A	N/A	N/A
R7	Avista Corporation - Dollar Road	2406 N. Dollar Road	Task Force groundwater memo; WA Ecology cleanup website site search	729	779	Spokane Valley	Spokane	Yes	Unknown source for original investigation. Later, found PCBs in trash pit on newly purchased parcel.	Yes	Other	Outside of area	Spokane River		N/A	N/A	N/A	N/A

Site Details				Location					On-site PCB Use		Discharges				Permitted Discharges			
Map ID	Site Name	Address	Information Source	WA Ecology Facility Site ID (FS ID)	WA Ecology Cleanup Site ID (CS ID)	City	County	Within Spokane City Limits?	Nature of PCB-related Operations	PCBs On-site?	Discharge Type	Discharge Detail	Waterbody/ Sewershed	Additional Discharges	Permit Type	Number	With PCB Information?	Notes
R173	FUDS RRA 3 Dartford	N/A	WA Ecology cleanup website site search	25863962	2610	Dartford	Spokane	No	US EPA's Superfund database includes 28 archived radio relay sites and 1 active site. 27 are located in Alaska. Alaska's list of Contaminated Sites includes 7 Cold War-era USAF radio relay sites. PCB impacts were confirmed at 4 out of the 7 sites and suspected at a fifth. Most PCB impacts arose from transformers and related equipment. Also, not all PCB-containing equipment was removed from radio relay sites after deactivation (ATSDR, 2014).	Not evaluated		Unknown			None			
R191	FUDS RRA Reardan	T26N R39E SEC 35	US EPA Superfund website search	N/A	N/A	Reardan	Lincoln	No	US EPA's Superfund database includes 28 archived radio relay sites and 1 active site. 27 are located in Alaska. Alaska's list of Contaminated Sites includes 7 Cold War-era USAF radio relay sites. PCB impacts were confirmed at 4 out of the 7 sites and suspected at a fifth. Most PCB impacts arose from transformers and related equipment. Also, not all PCB-containing equipment was removed from radio relay sites after deactivation (ATSDR, 2014).	Not evaluated		Unknown			N/A			
R169	FUDS RRA 7 Davenport	N/A	WA Ecology website search	48512859	1791	Davenport	Lincoln	No	US EPA's Superfund database includes 28 archived radio relay sites and 1 active site. 27 are located in Alaska. Alaska's list of Contaminated Sites includes 7 Cold War-era USAF radio relay sites. PCB impacts were confirmed at 4 out of the 7 sites and suspected at a fifth. Most PCB impacts arose from transformers and related equipment. Also, not all PCB-containing equipment was removed from radio relay sites after deactivation (ATSDR, 2014).	Not evaluated		Unknown			None			
R171	Nike 87 (Launch)																	
R170	FUDS Fairchild Nike 87	441 W. Sharp Avenue (from WA Ecology) 22210 W. Sprague Road (from Superfund database)	WA Ecology website search	81836974	514	Spokane	Spokane	No	PCBs were used at Nike sites in transformers and other electrical equipment. Transformer often remained on-site after deactivation. Waste oils used to control plant growth on the site and waste fluids were periodically dumped on- or off-site in unofficial manners, during regular site operations and site deactivation. Nike sites were a standard design and filled similar roles regardless of location.	Yes					N/A	N/A	N/A	N/A

Site Details				Location					On-site PCB Use		Discharges				Permitted Discharges			
Map ID	Site Name	Address	Information Source	WA Ecology Facility Site ID (FS ID)	WA Ecology Cleanup Site ID (CS ID)	City	County	Within Spokane City Limits?	Nature of PCB-related Operations	PCBs On-site?	Discharge Type	Discharge Detail	Waterbody/ Sewershed	Additional Discharges	Permit Type	Number	With PCB Information?	Notes
R172	Fuds Fairchild Nike 45	22802 W. Washington Road	WA Ecology website search	127	2680	Medical Lake	Spokane	No	Unclear. Operations were most likely closed (transformers and other electrical equipment). Equipment may have been left on-site after deactivation. Nike sites were a standard design and filled similar roles regardless of location.	Yes	Other	Infiltration and evaporation			N/A	N/A	N/A	N/A

Notes:
CSO = Combined Sewer Overflow; ECHO = Enforcement and Compliance History Online; FAA = Federal Aviation Administration; FTTS = Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA)/Toxic Substances Control Act (TSCA) Tracking System; GE = General Electric; MGD = Millions of Gallons Per Day; N/A = Not Available; NPDES = National Pollutant Discharge Elimination System; PCB = Polychlorinated Biphenyl; RM = River Mile; SIU = Significant Industrial User; Task Force = Spokane River Regional Toxics Task Force; US EPA = United States Environmental Protection Agency; USAF = United States Air Force; UST = Underground Storage Tank; WA Ecology = Washington State Department of Ecology; WWTP = Wastewater Treatment Plant.

Table A5.3b Results of Upland PCB Site Research – Permitted Dischargers

Site Details				Location					On-site PCB Use		Discharges				Permitted Discharges			
Map ID	Site Name	Address	Information Source	WA Ecology Facility Site ID (FS ID)	WA Ecology Cleanup Site ID (CS ID)	City	County	Within Spokane City Limits?	Nature of PCB-related Operations	PCBs On-site?	Discharge Type	Discharge Detail	Waterbody/ Sewershed	Additional Discharges	Permit Type	Number	With PCB Information?	Notes
D28	Brenntag Pacific Inc./ Great Western Chemical	1402 N. Thierman Road	Riverside WWTP SIU	643	1210	Spokane	Spokane	Yes	None known. Chemical supply and distribution.	Unknown	Permitted Discharge	SIU	Spokane Riverside WWTP		SIU	IU-5169-01	No, but total toxic organics (TTO), including PCBs, analyzed as part of the permit application process in 2013.	
D82	Fairchild Air Force Base Superfund Site	202 Doolittle Avenue	Riverside WWTP SIU; WA Ecology website Search	18213	13087	Spokane	Spokane	No	None known. Use of transformers and storage until disposal off-site.	Yes	Permitted Discharge	SIU	Spokane Riverside WWTP		Current Wastewater Discharge Permit. Former NPDES permits.	SIU-4581-01	Yes	Wastewater Discharge Permit (SIU-4581-01): PCB concentration 2.39×10^{-6} ppm (average) and 5.647×10^{-6} ppm (maximum) in 2010 and 2011. Not regulated. No information available on PCB levels in former NPDES permits.
D33	Ford State Fish Hatchery		NPDES	N/A	N/A	Ford	Stevens	No	PCBs not detected in fish food or in hatchery fish.	No	Permitted Discharge	NPDES			NPDES	WAG137012	Federal permit expired in 2015. Appears to be closed.	
D98	Honeywell Electronic Materials	15128 E. Euclid Avenue	Monsanto Invoices; SCRWRF SIU	N/A	N/A	Spokane	Spokane	Yes	Purchased PCB products. FR Heat Transfer Fluid.	Yes	Permitted Discharge	SIU	Spokane Riverside WWTP		SIU	SIU-3471-01	N/A	
D52	Hollister Stier	3525 N. Regal Street	PCB National Report (2009, 2017); Riverside WWTP SIU	N/A	N/A	Spokane	Spokane	Yes	Unconfirmed. Included on US EPA PADS list as a generator.	Yes	Permitted Discharge	SIU	Spokane Riverside WWTP		SIU	ST-8092		No categorical pretreatment standards, but lists local limits and 40 CFR Part 439 Pharmaceutical Manufacturing Categorical Pretreatment Standards for New Sources, Subpart B, Natural Extraction Operation and Subpart D, Mixing, Compounding, or Formulating Operation.
D86	Inland Empire Paper Company	3320 N. Argone Road	Task Force groundwater memo	81484342	4681	Millwood	Spokane	No	Use and discharge.	Yes	Permitted Discharge	Site system	Spokane River		NPDES	WA0000825	Yes	Average flow around 4 MGD, and estimated PCB loads 0.04 g/day (2001), 0.08 g/day (2005).
D111	Liberty Lake Sewer District WWTP		NPDES			Liberty Lake	Spokane	No	None known. WWTP.	Unknown	Permitted Discharge	NPDES	Spokane River		NPDES. Site-specific.	WAL045144/ WA0045144	No, permit requires PCB reporting two times per permit cycle. Permit requires wastewater effluent PCB testing (congener 1668) four times per year and wastewater influent PCB testing (congener 1668) bimonthly.	PCB information collected will be analyzed by WA Ecology to establish performance-based PCB effluent limitations for the following permit cycle. The City must prepare public media educating the public about PCB-free *vs.* non-PCB products.
D54	Riverside Park Water Reclamation Facility (Riverside WWTP) and CSOs		NPDES			Spokane	Spokane	Yes	None known. WWTP.	Unknown	Permitted Discharge	NPDES	Spokane River		NPDES. Site-specific.	WAL024473/ WA0024473	No, permit requires PCB reporting once per permit cycle. Total PCB testing required: Raw sewage = July, November-May. Final Effluent = 1 per quarter. Biosolids = 2 per year (winter and summer).	PCB information collected will be analyzed by WA Ecology to establish performance-based PCB effluent limitations for the following permit cycle. The City must prepare public media educating the public about PCB-free *vs.* non-PCB products.
D13	Spokane County Regional Water Reclamation Facility (SCRWRF)		NPDES			Spokane	Spokane	Yes	None known. WWTP.	Unknown	Permitted Discharge	NPDES	Spokane River		NPDES. Site-specific.	WA0093317	No, but required to sample for PCBs in influent once every 2 months and effluent once per quarter (24-hour composite). Also, surface water monitoring required upstream/downstream twice a year.	Quantification limit with EPA Method 1668 of 10 ppt per congener.
D116	Post Falls WWTP		NPDES			Post Falls	Kootenai	No	None known. WWTP.	Unknown	Permitted Discharge	NPDES	Spokane River		NPDES. Site-specific.	ID0025852	No, but required to sample for PCBs in influent once every 2 months and effluent once per quarter (24-hour composite). Also surface water monitoring required upstream/downstream twice a year.	Permittee must not allow any person to discharge water to the POTW in excess of any pretreatment local limit established by the POTW, or 3 ppb, whichever is less.

Site Details				Location					On-site PCB Use		Discharges				Permitted Discharges			
Map ID	Site Name	Address	Information Source	WA Ecology Facility Site ID (FS ID)	WA Ecology Cleanup Site ID (CS ID)	City	County	Within Spokane City Limits?	Nature of PCB-related Operations	PCBs On-site?	Discharge Type	Discharge Detail	Waterbody/ Sewershed	Additional Discharges	Permit Type	Number	With PCB Information?	Notes
D117	Hayden Area Regional Sewer Board WWTP		NPDES			Hayden	Kootenai	No	None known. WWTP.	Unknown	Permitted Discharge	NPDES	Spokane River		NPDES. Site-specific.	ID0026590	No, but required to sample for PCBs in influent once every 2 months and effluent once per quarter (24-hour composite). Also surface water monitoring required upstream/downstream twice a year.	Permittee must not allow any person to discharge water to the POTW in excess of any pretreatment local limit established by the POTW, or 3 ppb, whichever is less.
D112	Coeur d'Alene WWTP		NPDES			Coeur d'Alene	Kootenai	No	None known. WWTP.	Unknown	Permitted Discharge	NPDES	Spokane River		NPDES. Site-specific.	ID0022853	No, but required to sample for PCBs in influent once every 2 months and effluent once per quarter (24-hour composite). Also surface water monitoring required upstream/downstream twice a year.	Permittee must not allow any person to discharge water to the POTW in excess of any pretreatment local limit established by the POTW, or 3 ppb, whichever is less.
D32	Spokane Tribal Fish Hatchery		NPDES	N/A	N/A	Ford	Stevens	No	PCBs present in fish food.	Yes	Permitted Discharge	NPDES			NPDES	WAG130019	No	Generally federal permit has less requirements than state permit
D78	Spokane International Airport	9000 W. Airport Drive		6332493	7047	Spokane	Spokane	Yes	None known. PCBs are not knowingly used; however, PCBs have been found in collected deicer waste.	Yes	Permitted Discharge	Infiltration and evaporation	Unnamed aquifer	Spokane International Airport collects deicer waste and discharges it *via* a land application permit. It manages stormwater by direct discharge to land. Surrounding area in City of Spokane is managed by I&I.	Temporary State Waste (Stormwater) Discharge Permit	ST0045499, SIU-4581-XX	PCB concentration reported in deicer fluid waste is 6,140 ppt.	Temporary State Waste (Stormwater) Discharge Permit ST0045499, granted in 2011 and currently active. Wastewater Discharge Permit SIU-4581-XX, approved in 2012 but never used because Seattle International Airport could not meet discharge limits. Application for permit to discharge to groundwater *via* land application is pending approval.
D38	Spokane State Fish Hatchery		US EPA Region X	N/A	N/A	Spokane	Spokane	No	PCBs present in fish food (sum Aroclor is 16.4 ng/g).	Yes	Permitted Discharge	NPDES	Little Spokane River		NPDES	WAG137007	No	
D198	Cheney WWTP		US EPA Region X			Cheney	Spokane	No	None known. WWTP.	Unknown	Permitted Discharge	NPDES	West Medical Lake		NPDES. Site-specific.	WA0020842	No, but the permit requires 24-hour composite sampling for priority pollutants, including PCBs, in March 2019.	
D199	Clarkia Water and Sewer District WWTP		NPDES			Clarkia	Shoshone	No	None known. WWTP.	Unknown	Permitted Discharge	NPDES	West Fork Saint Maries River		NPDES. Site-specific.	ID0025071	No	
D200	Freeman School District 358		NPDES			Valleyford	Spokane	No	None known. Site-specific NPDES.	Unknown	Permitted Discharge	NPDES	Little Cottonwood		NPDES. Site-specific.	WA0045403	No	
D201	Harrison WWTP		NPDES			Harrison	Kootenai	No	None known. WWTP.	Unknown	Permitted Discharge	NPDES	Coeur d'Alene River		NPDES. Site-specific.	ID0021997	No	
D202	Lucky Friday Mine		NPDES			Mullan	Shoshone	No	None known. Site-specific NPDES.	Unknown	Permitted Discharge	NPDES	South Fork Coeur d'Alene River		NPDES. Site-specific.	ID0000175	No, but the permittee must notify IDDEQ of routine releases of toxic pollutants not on the permit greater than 100 ppb, and of non-routine releases of toxic pollutants greater than 500 ppb.	
D203	Medical Lake WWTP		NPDES			Medical Lake	Spokane	No	None known. WWTP.	Unknown	Permitted Discharge	NPDES	Deep Creek		NPDES. Site-specific.	WA0021148	No, but the permit requires 24-hour composite sampling for priority pollutants, including PCBs, three times during the permit cycle.	
D176	Sandpoint Fish Hatchery		NPDES						None known. Hatchery.	Yes	Permitted Discharge	NPDES			NPDES. US EPA Region X Aquaculture Permit		No longer in operation.	
D177	Cabinet Gorge Hatchery		NPDES						None known. Hatchery.	Yes	Permitted Discharge	NPDES	Clark Fork River		NPDES. US EPA Region X Aquaculture Permit	IDG130075	Sediment sampling is required.	
D63	Spokane City (Sewer Maintenance Dept.)		NPDES			Spokane	Spokane	Yes	None known. MS4.	Unknown	Permitted Discharge	NPDES	Not stated		NPDES. Municipal Stormwater Phase II.	WAR046505	No PCB-specific requirements listed in the draft general permit for Eastern Washington Phase II Municipal Stormwater.	TMDL monitoring only required for phosphorus, ammonia, CBOD, and flow rates.
D196	Airway Heights WWTP		NPDES			Airway Heights	Spokane	No	None known. WWTP.	Unknown	Permitted Discharge	NPDES	Deep Creek		NPDES	WAL011457	Unknown, permit not available in PARIS system.	

Site Details				Location					On-site PCB Use		Discharges				Permitted Discharges			
Map ID	Site Name	Address	Information Source	WA Ecology Facility Site ID (FS ID)	WA Ecology Cleanup Site ID (CS ID)	City	County	Within Spokane City Limits?	Nature of PCB-related Operations	PCBs On-site?	Discharge Type	Discharge Detail	Waterbody/ Sewershed	Additional Discharges	Permit Type	Number	With PCB Information?	Notes
D197	Caladay, Coeur, And Galena Mines		NPDES			Wallace	Shoshone	No	None known. Site-specific NPDES.	Unknown	Permitted Discharge	NPDES	Lake Creek		NPDES. Site-specific.	ID0000027	No, but the permittee must notify IDDEQ of routine releases of toxic pollutants not on the permit greater than 100 ppb, and of non-routine releases of toxic pollutants greater than 500 ppb.	
D204	Mullan WWTP		NPDES			Mullan	Shoshone	No	None known. WWTP.	Unknown	Permitted Discharge	NPDES	South Fork Coeur d'Alene River		NPDES. Site-specific.	ID0021296	No	
D205	Page WWTP		NPDES			Smelterville	Shoshone	No	None known. WWTP.	Unknown	Permitted Discharge	NPDES	South Fork Coeur d'Alene River		NPDES. Site-specific.	ID0021300	No, but the permittee is required to monitor whole effluent toxicity quarterly.	
D206	Plummer WWTP		NPDES			Plummer	Benewah	No	None known. WWTP.	Unknown	Permitted Discharge	NPDES	Plummer Creek		NPDES. Site-specific.	ID0022781	No	
D207	Post Falls MS4		NPDES			Post Falls	Kootenai	No	None known. MS4.	Unknown	Permitted Discharge	NPDES	City Reclaimed Water System		NPDES. MS4 permit.	IDS028231	Yes, total PCB sampling required 4 times per year.	Permittee must determine if MS4 outflow contributes pollutants of concern, including PCBs.
D208	Potlatch Corporation Saint Maries Complex		NPDES			Saint Maries	Benewah	No	None known. Site-specific NPDES, general stormwater NPDES.	Unknown	Permitted Discharge	NPDES	Saint Joe River		NPDES. Site-specific: admin. continued. General Industrial Stormwater: Active. General Industrial Stormwater: Inactive.	ID0000019, IDR05I310, IDR05B62I	No, administratively continued permit required that the permittee must notify IDDEQ of routine releases of toxic pollutants not on the permit greater than 100 ppb, and of non-routine releases of toxic pollutants greater than 500 ppb. No PCB monitoring required in other stormwater permits.	
D209	Rockford WWTP		NPDES			Rockford	Spokane	No	None known. WWTP.	Unknown	Permitted Discharge	NPDES	Rock Creek		NPDES. Site-specific.	WA0044831	No	
D210	Smelterville WWTP		NPDES			Smelterville	Shoshone	No	None known. WWTP.	Unknown	Permitted Discharge	NPDES	South Fork Coeur d'Alene River		NPDES. Site-specific.	ID0020117	No	
D211	Spangle STP		NPDES			Spangle	Spokane	No	None known. Site-specific NPDES.	Unknown	Permitted Discharge	NPDES	Spangle Creek		NPDES. Site-specific.	WA0991010	No, but the permit requires 24-hour composite sampling for priority pollutants including PCBs in March 2019.	
D212	Saint Maries WWTP		NPDES			Saint Maries	Benewah	No	None known. WWTP.	Unknown	Permitted Discharge	NPDES	Saint Joe River		NPDES. Site-specific.	ID0022799	No, but the permittee is required to monitor whole effluent toxicity on 24-hour composite samples at least four times every 5 years.	
D213	Tekoa STP		NPDES			Tekoa	Whitman	No	None known. Site-specific NPDES.	Unknown	Permitted Discharge	NPDES	Hangman Creek		NPDES. Site-specific.	WA0023141	No	
D214	Worley WWTP		NPDES			Worley	Kootenai	No	None known. WWTP.	Unknown	Permitted Discharge	NPDES	Rock Creek		NPDES. Site-specific.	ID0022713	No	
D215	Spokane County Stormwater		NPDES			Spokane	Spokane	Yes	None known. MS4.	Unknown	Permitted Discharge	NPDES	Spokane River		NPDES. Municipal Stormwater Phase II.	WAR046506	No PCB-specific requirements listed in the draft general permit for Eastern Washington Phase II Municipal Stormwater.	
D216	Spokane Valley City		NPDES			Spokane Valley	Spokane	Yes	None known. MS4.	Unknown	Permitted Discharge	NPDES	Not stated		NPDES. Municipal Stormwater Phase II.	WAR046507	No PCB-specific requirements listed in the draft general permit for Eastern Washington Phase II Municipal Stormwater.	
D217	Washington State University Spokane		NPDES			Spokane	Spokane	Yes	None known. MS4.	Unknown	Permitted Discharge	NPDES	Spokane River		NPDES. Municipal Stormwater Phase II.	WAR046701	No PCB-specific requirements listed in the draft general permit for Eastern Washington Phase II Municipal Stormwater.	
D218	Santa Fernwood Sewer District WWTF		NPDES			Fernwood	Benewah	No	None known. WWTP.	Unknown	Permitted Discharge	NPDES	Saint Maries River		NPDES. Site-specific.	ID0022845	No	
D119	Idaho Transportation Department - District #1 (MS4)		NPDES			Coeur d'Alene	Kootenai	No	None known. MS4.	Unknown	Permitted Discharge	NPDES	French Gulch/ Fernan Creek		NPDES. MS4 permit.	IDS028223	No, but total PCB sampling required 4 times per year.	Permittee must determine if MS4 outflow contributes pollutants of concern, including PCBs.
D118	Lakes Highway District (MS4)		NPDES			Hayden Lake	Kootenai	No	None known. MS4.	Unknown	Permitted Discharge	NPDES	French Gulch/ Fernan Creek		NPDES. MS4 permit.	IDS028207	No	Permittee must determine if MS4 outflow contributes pollutants of concern, including PCBs.

Site Details				Location					On-site PCB Use		Discharges				Permitted Discharges			
Map ID	Site Name	Address	Information Source	WA Ecology Facility Site ID (FS ID)	WA Ecology Cleanup Site ID (CS ID)	City	County	Within Spokane City Limits?	Nature of PCB-related Operations	PCBs On-site?	Discharge Type	Discharge Detail	Waterbody/ Sewershed	Additional Discharges	Permit Type	Number	With PCB Information?	Notes
D120	Post Falls Highway District (MS4)		NPDES			Post Falls	Kootenai	No	None known. MS4.	Unknown	Permitted Discharge	NPDES	Hayden Lake		NPDES. MS4 permit.	IDS028193	No	Permittee must determine if MS4 outflow contributes pollutants of concern, including PCBs.
D89	Ecolite Manufacturing Co.	10025 E. Montgomery Drive	Other SIU	N/A	N/A	Spokane	Spokane	Yes	Unknown	Unknown	Permitted Discharge	SIU	Spokane County		SIU	Unknown	N/A	
D30	Franz Family Bakery	110 N. Fancher Road	Other SIU	N/A	N/A	Spokane	Spokane	Yes	Unknown	Unknown	Permitted Discharge	SIU	Spokane Riverside WWTP		SIU	Unknown	N/A	
D6	Inland Empire Plating	2401 N. Eastern Road	Other SIU	634	1182	Spokane	Spokane	Yes	Unknown	Unknown	Permitted Discharge	SIU	Unknown		SIU	Unknown	N/A	
D45	Leisure Concepts	5342 N. Florida Street	Other SIU	N/A	N/A	Spokane	Spokane	Yes	Unknown	Unknown	Permitted Discharge	SIU	Unknown		SIU	Unknown	N/A	
D43	Mister Car Wash	1615 W. Five Mile Road	Other SIU	14912815	8062	Spokane	Spokane	Yes	Unknown	Unknown	Permitted Discharge	SIU	Unknown		SIU	Unknown	N/A	
D133	Northside Landfill Pilot Extraction Well	7202 N. Nine Mile Road	Other SIU	111	2500	Spokane	Spokane	Yes	Unknown	Unknown	Permitted Discharge	SIU	Unknown		SIU	Unknown	N/A	
D134	Northwest Waste Solutions	3808 N. Sullivan Road # 10	Other SIU	N/A	N/A	Spokane Valley	Spokane	No	Unknown	Unknown	Permitted Discharge	SIU	Unknown		SIU	Unknown	N/A	
D16	Triple Plate Chrome	2302 E. Trent Avenue	Other SIU	N/A	N/A	Spokane	Spokane	Yes	Unknown	Unknown	Permitted Discharge	SIU	Unknown		SIU	Unknown	N/A	
D46	Dash Connector Technology	3915 E. Francis C-6	Riverside WWTP SIU	N/A	N/A	Spokane	Spokane	Yes	None known. Manufacturing.	Unknown	Permitted Discharge	SIU	Spokane Riverside WWTP		SIU	IU-3471-10	No, but required to sample for total toxic organics (TTO) every 6 months. Can opt to develop a toxic organics management plan in place of sampling every 6 months.	Discharge limits on total toxic organics (TTO), which includes PCBs, of 2.13 ppm as a daily maximum limit; no monthly average limit.
D4	ALSCO-Steiner Corp.	1923 North Waterworks Road	Riverside WWTP SIU	N/A	N/A	Spokane	Spokane	Yes	None known. Industrial wet laundry and linen rental supply.	Unknown	Permitted Discharge	SIU	Spokane Riverside WWTP		SIU	IU-7211-01	No, but permit wastewater discharge characterization includes analysis of priority pollutants, which include PCBs.	No categorical pretreatment standards.
D79	International Aerospace Coatings f/k/a Associated Painters	8510 W. Electric Avenue	Riverside WWTP SIU	N/A	N/A	Spokane	Spokane	Yes	None known. Chemical stripping and etching, mechanical removal and application of aircraft paint.	Unknown	Permitted Discharge	SIU	Spokane Riverside WWTP		SIU	SIU-4581-02	No, but required to sample for total toxic organics (TTO) every 6 months.	Pretreatment standards per 40 CFR Part 433.17 (Metals Finishing Categorical Pretreatment Standards for New Sources). Discharge limits on total toxic organics (TTO), which includes PCBs, of 2.13 ppm as a daily maximum limit; no monthly average limit.
D44	Darigold Spokane (CIU)	33 E. Francis Avenue	Riverside WWTP SIU	54931278	9667	Spokane	Spokane	Yes	None known. Manufacturing and packaging of dairy products and fruit juice, plastic container forming.	Unknown	Permitted Discharge	SIU	Spokane Riverside WWTP		SIU	SIU-2026-01 (also listed as CIU-2026-01 and IU-2026-01)	No, but required to sample priority pollutants, including PCBs, once per permit cycle (24-hour composites).	No categorical pretreatment standards.
D64	EZ Loader Boat Trailers	717 N. Hamilton Street	Riverside WWTP SIU	N/A	N/A	Spokane	Spokane	Yes	None known. Manufacturing of boat trailers, including conversion coating preparation for powder coating.	Unknown	Permitted Discharge	SIU	Spokane Riverside WWTP		SIU	IU-3479-02	No, but quarterly monitoring for total toxic organics (TTO) required. The facility can choose to submit a toxic organics management plan to be approved by the City of Spokane instead of monitoring quarterly (this option has historically been used by EZ Loader Boat Trailer).	Pretreatment standards per 40 CFR Part 433.17 (Metals Finishing Categorical Pretreatment Standards for New Sources). Discharge limits on total toxic organics (TTO), which includes PCBs, of 2.13 ppm as a daily maximum limit; no monthly average limit.
D11	Global Metal Technologies	3200 E. Trent Avenue, Suite A, Building 1	Riverside WWTP SIU	N/A	N/A	Spokane	Spokane	Yes	None known. Processing of ore to concentrate precious metals.	Unknown	Permitted Discharge	SIU	Spokane Riverside WWTP		SIU	IU-3339-01	No, but permit requires one-time sampling (within first 90 days of discharge) for total toxic organics (TTO; grab sample) to characterize the facility's wastewater discharge.	No categorical pretreatment standards. Discharge limits on total toxic organics (TTO), which includes PCBs, of 2.15 ppm as a daily maximum limit; no monthly average limit.
D84	Goodrich Spokane-UTC Aerospace Systems	11135 W. Westbow Boulevard	Riverside WWTP SIU	N/A	N/A	Spokane	Spokane	Yes	None known. Manufacturing of carbon disk pads for aircraft brakes.	Unknown	Permitted Discharge	SIU	Spokane Riverside WWTP		SIU	SIU-3728-01	No, but sampling for total toxic organics (TTO), which includes PCBs, required in August 2016 (4 grab samples) at outfall 001.	No categorical pretreatment standards.

Site Details				Location					On-site PCB Use		Discharges				Permitted Discharges			
Map ID	Site Name	Address	Information Source	WA Ecology Facility Site ID (FS ID)	WA Ecology Cleanup Site ID (CS ID)	City	County	Within Spokane City Limits?	Nature of PCB-related Operations	PCBs On-site?	Discharge Type	Discharge Detail	Waterbody/ Sewershed	Additional Discharges	Permit Type	Number	With PCB Information?	Notes
D75	Johanna Beverage f/k/a Olympic Foods	5625 W. Thorpe Road	Riverside WWTP SIU	N/A	N/A	Spokane	Spokane	Yes	None known. Manufacturing containers for products.	Unknown	Permitted Discharge	SIU	Spokane Riverside WWTP		SIU	IU-2834-01	No, but sampling for priority pollutants, which includes PCBs, required once per permit cycle (24-hour composite).	No categorical pretreatment standards, but lists local limits and 40 CFR Part 439 Pharmaceutical Manufacturing Categorical Pretreatment Standards for New Sources, Subpart B, Natural Extraction Operation and Subpart D, Mixing, Compounding, or Formulating.
D73	Providence Sacred Heart Laundry	PO Box 2555	Riverside WWTP SIU	N/A	N/A	Spokane	Spokane	Yes	None known. Industrial laundry washing.	Unknown	Permitted Discharge	SIU	Spokane Riverside WWTP		SIU	N/A	No, but priority pollutants, including PCBs, required to be sampled once per permit cycle (4 grab samples/event).	No categorical pretreatment standards.
D65	Spokane Metal Finishing	1519 E. Trent Avenue	Riverside WWTP SIU	N/A	N/A	Spokane	Spokane	Yes	None known. Metal finishing.	Unknown	Permitted Discharge	SIU	Spokane Riverside WWTP		SIU	IU-3471-08	No, but sampling for total toxic organics (TTO), which includes PCBs, required every 6 months.	Pretreatment standards per 40 CFR Part 433.17 (Metals Finishing Categorical Pretreatment Standards for New Sources). Discharge limits on total toxic organics (TTO), which includes PCBs, of 2.13 ppm as a daily maximum limit; no monthly average limit.
D77	Triumph Composite Systems	1514 S. Flint Road	Riverside WWTP SIU	N/A	N/A	Spokane	Spokane	Yes	None known. Manufacture of air ducts, floor panels, polyester resins, and ducting.	Unknown	Permitted Discharge	SIU	Spokane Riverside WWTP		SIU	N/A	No, but sampling for total toxic organics (TTO), which includes PCBs, required for permit application, but not specified as part of the permit sampling requirements. In 2011, Triumph Composite Systems had no monitoring requirements.	No categorical pretreatment standards.
D90	Galaxy Compound Semiconductors, Inc.	9922 East Montgomery Avenue	SCRWRF SIU	N/A	N/A	Spokane	Spokane	Yes	None known. Electric and electronic components manufacturing and metal finishing.	Unknown	Permitted Discharge	SIU	Spokane County		SIU	SIU-3499-01	N/A	Pretreatment standards per 40 CFR Part 433 (Metals Finishing) and Part 469.
D103	American On-Site Services	3808 N. Sullivan Road, Bldg. 107	SCRWRF SIU	N/A	N/A	Spokane Valley	Spokane	No	None known. Portable chemical toilet service.	Unknown	Permitted Discharge	SIU	Spokane County		SIU	SIU-7359	N/A	No categorical pretreatment standards.
D81	Exotic Metals Forming	12821 W. McFarlane Road	SCRWRF SIU	N/A	N/A	Airway Heights	Spokane	No	None known. Metals forming.	Unknown	Permitted Discharge	SIU	Spokane County		SIU	SIU-3728-02	No, but required to sample for total toxic organics (TTO) every 6 months.	Discharge limits on total toxic organics (TTO), which includes PCBs, of 2.10 ppm as a maximum allowable discharge limit; no monthly average limit.
D104	Lloyd Industries, LLC	3808 N. Sullivan Road, Building 25 East	SCRWRF SIU	N/A	N/A	Spokane	Spokane	Yes	None known. Aluminum forming and metal finishing.	Unknown	Permitted Discharge	SIU	Spokane County		SIU	SIU-3471-03 (as of 2010, discharged to NVI and then Riverside WWTP)	No, but sampling for total toxic organics (TTO) required once per permit cycle (4 grab samples/event).	Pretreatment standards per 40 CFR 467: Aluminum Forming; 40 CFR 433: Metal Finishing. Discharge limits on total toxic organics (TTO), which includes PCBs, of 2.13 ppm as a daily maximum limit; no monthly average limit.
D91	Novation, Inc.	2616 N. Locust Road, Spokane Valley	SCRWRF SIU	N/A	N/A	Spokane Valley	Spokane	No	None known. Electroplating, metal finishing.	Unknown	Permitted Discharge	SIU	Spokane County		SIU	SIU-3471-02	No, total toxic organics (TTO) (and PCBs) not on list of required monitoring parameters.	Pretreatment standards per 40 CFR 433: Metal Finishing; 40 CFR 413: Electroplating. Discharge limits on total toxic organics (TTO), which includes PCBs, of 2.13 ppm as a daily maximum limit; no monthly average limit.
D76	Reliance Trailer Company	3025 S. Geiger Boulevard	SCRWRF SIU	N/A	N/A	Spokane	Spokane	Yes	None known. Metal finishing.	Unknown	Permitted Discharge	SIU	Spokane County		SIU	ST-8092	No, total toxic organics (TTO) not on list of required monitoring parameters, but monitoring is required to verify that effluent limitations are being achieved.	Discharge limits on total toxic organics (TTO), which includes PCBs, of 2.13 ppm as a daily maximum limit; no monthly average limit.

Site Details				Location					On-site PCB Use		Discharges				Permitted Discharges			
Map ID	Site Name	Address	Information Source	WA Ecology Facility Site ID (FS ID)	WA Ecology Cleanup Site ID (CS ID)	City	County	Within Spokane City Limits?	Nature of PCB-related Operations	PCBs On-site?	Discharge Type	Discharge Detail	Waterbody/ Sewershed	Additional Discharges	Permit Type	Number	With PCB Information?	Notes
D99	Kemira Water Solutions, Inc.	2315 N. Sullivan Road	SCRWRF SIU	N/A	N/A	Spokane Valley	Spokane	No	None known. Chemical	Unknown	Permitted Discharge	SIU	Spokane County		SIU	SIU-2819-01	No	

Notes:

CIU = Categorical Industrial User; CBOD = Carbonaceous Biological Oxygen Demand; CSO = Combined Sewer Overflow; f/k/a = Formerly Known As; I&I = Injection and Infiltration; IDDEQ = Idaho Department of Environmental Quality; MGD = Millions of Gallons Per Day; MS4 = Municipal Separate Storm Sewer System; N/A = Not Available; NPDES = National Pollutant Discharge Elimination System; NVI = North Valley Interceptor; PADS = PCB Activity Database; PARIS = Permitting and Reporting Information System; PCB = Polychlorinated Biphenyl; POTW = Publicly Owned Treatment Works; SIU = Significant Industrial User; STP = Sewage Treatment Plant; Task Force = Spokane River Regional Toxics Task Force; TMDL = Total Maximum Daily Load; US EPA = United States Environmental Protection Agency; WA Ecology = Washington State Department of Ecology; WWTF = Wastewater Treatment Facility; WWTP = Wastewater Treatment Plant.

Table A5.3c Results of Upland PCB Site Research – Users

Site Details				Location					On-site PCB Use		Users					Discharges			
Map ID	Site Name	Address	Original List	WA Ecology Facility Site ID (FS ID)	WA Ecology Cleanup Site ID (CS ID)	City	County	Within Spokane City Limits?	Nature of PCB-related Operations	PCBs On-site?	Type?	Documented Spills?	Waste Manifest Information	PCB-related Violations	Notes	Discharge Type	Discharge Detail	Waterbody/ Sewershed	Additional Discharges
Multiple sites	Spokane School District	Multiple	ECHO database	N/A	N/A	Spokane	Spokane	Yes	PCB use subject to TSCA Section 6 PCB inspection. Minor violation.	Yes	TSCA Section 6, 9/20/1988	No	None	Violation details not found	N/A				N/A
U47	Able Clean-Up Technologies, Inc.	4117 E. Nebraska Avenue	PCB National Report (2009, 2017)	N/A	N/A	Spokane	Spokane	Yes	Waste haulers and recyclers. Contracted for a PCB cleanup in 2007.	No	Transporter	None	None	None	Contracted PCB cleanup at 4701 East Valley Springs Road on 7/2/2007.	Sewer	MS4	Cochran	
U59	Avista Development, Inc. (HQ)	1411 East Mission Avenue	PCB National Report (2009, 2017); LimnoTech PCB reduction report	31739484	3512	Spokane	Spokane	Yes	Utility. No PCBs known to be present at this location. Operate transformers throughout the watershed.	Not on-site. Transformers located throughout area.	Generator	None	None	None	Avista has contested their inclusion on the transformer database, stating that their last regulated transformer was removed in 2015.	Sewer	MS4	Mission Street (1400500ND)	
U27	Central Solvents & Chemicals	6308 E. Sharp Avenue	Monsanto Customer Records; Monsanto Invoices	696	1236	Spokane	Spokane	Yes	Purchased PCB products.	Yes	Unknown, likely generator	None	None	None	Purchased PCB oil in 1971.	Other	Outside of area		
U115	Cheney Utility Building	112 Anderson Road	PCB National Report (2009, 2017)	52984148	9571	Cheney	Spokane	No	Utility. Municipal utility for Cheney, WA.	Yes	Generator	None	None	None	Utility building for Cheney, WA. PCB use unclear.	Other	Outside of area		
U17	Centennial Mills/ ADM Milling Co.	2301 E. Trent Avenue	PCB National Report (2009, 2017); NPDES	N/A	N/A	Spokane	Spokane	Yes	Non-utility industrial equipment. Waste PCB oil from transformers.	Yes	Generator	None	PCB waste oil transported off-site to General Electric decommissioning facility.	None	Three transformers and two pails of PCB oil transported off-site in September 1987.	Permitted Discharge	NPDES	Chester Creek-Spokane River (HUC: 170103050402)	
U47	Able Clean-Up Technologies, Inc.	7915 N. Panarama Drive	PCB National Report (2009, 2017)	N/A	N/A	Spokane	Spokane	Yes	Waste haulers and recyclers.	Yes	Transporter	None	None	None	Alternate address for Able Clean-Up Technologies, Inc.	Other	Injection and Infiltration (I&I)	Special Drainage District	
U107	Circle-M Construction Company	12122 E. First	PCB National Report (2009, 2017)	68867823	N/A	Spokane	Spokane	Yes	Waste haulers and recyclers. Transported PCB waste from City Parcel site.	Yes	Transporter	None	PCB waste from City Parcel site.	None	Documented PCB waste transporter from the City Parcel cleanup site.	Other	Outside of area		
U72	Deaconess Medical Center/Empire Health Services	800 W. 5th Avenue	PCB National Report (2009, 2017)	N/A	N/A	Spokane	Spokane	Yes	Unconfirmed. Included on US EPA PADS list as a generator.	Yes	Generator	None	None	None	PCBs unconfirmed. Included on PCB National Report as a generator. Possibly medical equipment/generators. May be due to pre-1979 medical equipment and/or backup generators/electrical systems. No PCB transformers present. No reported PCB waste streams.	Sewer	CSO	CSO 26 (7th Street)	
U125	DSHS Medical Lake Complex	Salnave Road Highway 902	PCB National Report (2017)	N/A	N/A	Medical Lake	Spokane	No	Unconfirmed. Included on US EPA PADS list as a generator.	Yes	Generator	None	None	None	PCBs unconfirmed. Included on PCB National Report as a generator. Possibly medical equipment/generators. May be due to pre-1979 medical equipment and/or backup generators/electrical systems. No PCB transformers present. No reported PCB waste streams.	Other	Outside of area		

Site Details				Location					On-site PCB Use		Users					Discharges			
Map ID	Site Name	Address	Original List	WA Ecology Facility Site ID (FS ID)	WA Ecology Cleanup Site ID (CS ID)	City	County	Within Spokane City Limits?	Nature of PCB-related Operations	PCBs On-site?	Type?	Documented Spills?	Waste Manifest Information	PCB-related Violations	Notes	Discharge Type	Discharge Detail	Waterbody/ Sewershed	Additional Discharges
U96	Emerald Services Inc.	3808 N. Sullivan Road, Bldg. 11, Ste. C	PCB National Report (2009, 2017)	1695005	N/A	Spokane Valley	Spokane	Yes	Waste haulers and recyclers. Transported PCB waste. Used by City of Spokane.	Yes	Transporter	None	None	No	Non-hazardous used oil (<2 ppm) collected in Spokane area brought to Emerald facility and consolidated in larger tanks to be transported to their facility in Seattle. Hazardous oil is handled on a case-by-case basis with the city.	Other	Outside of area		
U85	Four Lakes Warehouse	10110 W. Hallett Road	National PCB Notifications or PCB Transformer Registry	N/A	N/A	Spokane	Spokane	Yes								Other	Outside of area		
U24	General Machinery Company	3500 East Riverside Avenue	PCB National Report (2009, 2017)	N/A	N/A	Spokane	Spokane	Yes	Unconfirmed. Included on US EPA PADS list as a generator.	Yes	Generator	None	None	None	US EPA-registered PCB Generator. The site is currently listed as a RCRA non-generator site, but was previously listed as a large-quantity generator.	Sewer	CSO	CSO 34 (Erie)	
U126	Inland Power and Light	10110 W. Hallett Road	PCB National Report (2009, 2017) LimnoTech PCB reduction report	N/A	N/A	Spokane	Spokane	Yes	Utility. No PCBs known to be present at this location. Operates transformers throughout the watershed.	Not on-site. Transformers located throughout area.	Generator	None	None	None	Owned and operated PCB-containing transformers in the Spokane area (facility address).	Other	Outside of area		
U126	Inland Power and Light	320 E. 2nd Avenue	PCB National Report (2009); LimnoTech PCB reduction report	N/A	N/A	Spokane	Spokane	Yes	Utility. No PCBs known to be present at this location. Operates transformers throughout the watershed.	Not on-site. Transformers located throughout area.	Generator	None	None	None	Owned and operated PCB-containing transformers in the Spokane area (mailing address).	Sewer	CSO	CSO 26 (7th Street)	
U108	James J. Williams Trucking Ltd.	16702 E. Euclid Avenue	PCB National Report (2009, 2017)	N/A	N/A	Spokane	Spokane	Yes	Waste haulers and recyclers.	Yes	Transporter	None	None	None	No additional information found.	Other	Outside of area		
U109	Kaiser Aluminum - Fabs Products Alutek	3401 N. Tschirley	ECHO database	N/A	N/A	Spokane	Spokane	Yes											
U148	Adams Elementary School	2909 E. 37th Avenue	EDR - FTTS	N/A	N/A	Spokane	Spokane	Yes	PCB use subject to TSCA Section 6 PCB inspection. No violations.	Yes	TSCA Section 6, 3/14/2000	No	None	No violations reported	N/A				N/A
U139	Bancroft Bi/ Pre-School (Cape)	1025 W. Spoffard Avenue	EDR - FTTS	N/A	N/A	Spokane	Spokane	Yes	PCB use subject to TSCA Section 6 PCB inspection. No violations.	Yes	TSCA Section 6, 6/23/1999, 3/15/2000	No	None	No violations reported	N/A				N/A
U156	Bay Liner Marine Corp.	E. 18001 Euclid	EDR - FTTS	N/A	N/A	Spokane	Spokane	Yes	PCB use subject to TSCA Section 6 PCB inspection. No violations.	Yes	TSCA Section 6, 04/26/1995	No	None	No violations reported	N/A				N/A
U188	Brian Gregg Site	1307 E. Walton	EDR - FTTS; ECHO database	N/A	N/A	Spokane	Spokane	Yes	PCB use subject to TSCA Section 6 PCB inspection. Minor violation.	Yes	TSCA Section 6, 7/6/1999, 8/18/1998, 12/31/1999	No	None	Failure to report	N/A				N/A
U180	Browne Elementary School	5134 N. Driscoll Boulevard	EDR - FTTS	N/A	N/A	Spokane	Spokane	Yes	PCB use subject to TSCA Section 6 PCB inspection. No violations.	Yes	TSCA Section 6, 5/02/2000	No	None	No violations reported	N/A				N/A
U183	Buckley Engineering Sales Co.	W 1028 Rosewood Avenue E.	EDR - FTTS	N/A	N/A	Spokane	Spokane	Yes	PCB use subject to TSCA Section 6 PCB inspection. No violations.	Yes	TSCA Section 6, 9/16/1987	No	None	No violations reported	N/A				N/A
U166	City of Spokane	3941 N. Sullivan Road Valley	EDR - FTTS	N/A	N/A	Spokane	Spokane	Yes	PCB use subject to TSCA Section 6 PCB inspection. No violations.	Yes	TSCA Section 6, 9/08/1999	No	None	No violations reported	N/A				N/A
U157	Clean Care Corp.	1815 S. Lewis Street	EDR - FTTS	N/A	N/A	Spokane	Spokane	Yes	PCB use subject to TSCA Section 6 PCB inspection. No violations.	Yes	TSCA Section 6, 9/07/1999	No	None	No violations reported	N/A				N/A

Site Details				Location					On-site PCB Use		Users					Discharges			
Map ID	Site Name	Address	Original List	WA Ecology Facility Site ID (FS ID)	WA Ecology Cleanup Site ID (CS ID)	City	County	Within Spokane City Limits?	Nature of PCB-related Operations	PCBs On-site?	Type?	Documented Spills?	Waste Manifest Information	PCB-related Violations	Notes	Discharge Type	Discharge Detail	Waterbody/ Sewershed	Additional Discharges
U154	Dellen Wood Products Inc.	3014 N. Flora Road	EDR - FTTS	N/A	N/A	Spokane	Spokane	Yes	PCB use subject to TSCA Section 6 PCB inspection. No violations.	Yes	TSCA Section 6, 5/20/1999	No	None	No violations reported	N/A				N/A
U149	Ferris High School	3020 E. 37th Avenue	EDR - FTTS	N/A	N/A	Spokane	Spokane	Yes	PCB use subject to TSCA Section 6 PCB inspection. No violations.	Yes	TSCA Section 6, 3/14/2000	No	None	No violations reported	N/A				N/A
U105	Modern Electric Water Co.	904 N. Pines Road	PCB National Report (2009, 2017); LimnoTech PCB reduction report	N/A	N/A	Spokane	Spokane	Yes	Utility. No PCBs known to be present at this location. Operates transformers throughout the watershed.	Not on-site. Transformers located throughout area.	Generator	None	None	None	Operates over 2,500 transformers in Spokane area. Replaced all transformers that had 10 ppm or greater PCBs. Approximately 10% of transformers have PCB levels less than 10 ppm.	Other	Outside of area		
U181	Finch Elementary School	3717 N. Milton Street	EDR - FTTS	N/A	N/A	Spokane	Spokane	Yes	PCB use subject to TSCA Section 6 PCB inspection. No violations.	Yes	TSCA Section 6, 5/02/2000	No	None	No violations reported	N/A				N/A
U147	Franklin Elementary	2627 E. 17th Avenue	EDR - FTTS	N/A	N/A	Spokane	Spokane	Yes	PCB use subject to TSCA Section 6 PCB inspection. No violations.	Yes	TSCA Section 6, 5/03/2000	No	None	No violations reported	N/A				N/A
U186	Glover Middle School	2404 W. Longfellow Avenue	EDR - FTTS	N/A	N/A	Spokane	Spokane	Yes	PCB use subject to TSCA Section 6 PCB inspection. No violations.	Yes	TSCA Section 6, 3/15/2000, 5/01/2000	No	None	No violations reported	N/A				N/A
U140	Gonzaga University	E. 502 Boone Avenue	EDR - FTTS	N/A	N/A	Spokane	Spokane	Yes	FTTS inspection (likely TSCA Section 6 PCB). Minor violation.	Yes	FTTS Inspection, 04/08/1987	No	None	Failure to report, label, mark, store, use, dispose of or inspect PCBs on-site	Fine: $29,325.00				N/A
U164	Hecla Mining Co.	6500 Mineral Drive	EDR - FTTS	N/A	N/A	Coeur d'Alene	Kootenai	No	PCB use subject to TSCA Section 6 PCB inspection. No violations.	Yes	TSCA Section 6, 1/05/1998	No	None	No violations reported	N/A				N/A
U146	Hutton Elementary School	908 E. 24th Avenue	EDR - FTTS	N/A	N/A	Spokane	Spokane	Yes	PCB use subject to TSCA Section 6 PCB inspection. No violations.	Yes	TSCA Section 6, 3/14/2000	No	None	No violations reported	N/A				N/A
U161	Idaho Forest Industries Inc.	2850 Seltice Way	EDR - FTTS	N/A	N/A	Coeur d'Alene	Kootenai	No	PCB use subject to TSCA Section 6 PCB inspection. No violations.	Yes	TSCA Section 6, 1/19/1999	No	None	No violations reported	N/A				N/A
U162	Idaho Forest Industries Inc.	926 River Avenue	EDR - FTTS	N/A	N/A	Coeur d'Alene	Kootenai	No	PCB use subject to TSCA Section 6 PCB inspection. No violations.	Yes	TSCA Section 6, 10/25/1990	No	None	No violations reported	N/A				N/A
U160	Idaho Veneer Co.	E. 704 4th Street, PO Box 339	EDR - FTTS	N/A	N/A	Post Falls	Kootenai	No	PCB use subject to TSCA Section 6 PCB inspection. No violations.	Yes	TSCA Section 6, 9/26/1988	No	None	No violations reported	N/A				N/A
U153	Inland Aqua-Tech Precious Metals, Inc. - Spokane	12121 E. Portland Avenue	ECHO database	N/A	N/A	Spokane	Spokane	Yes	PCB use subject to TSCA Section 6 PCB inspection. No violations.	Yes	TSCA Section 6, 12/11/1992	No	None	Violation details not found	Fine: $5,500.00				N/A
U182	Inland Foundry Co. Inc.	11250 Market Street	EDR - FTTS	N/A	N/A	Mead	Spokane	Yes	PCB use subject to TSCA Section 6 PCB inspection. No violations.	Yes	TSCA Section 6, 6/26/1995	No	None	No violations reported	N/A				N/A
U150	Libby Center	2900 E. First Avenue	EDR - FTTS	N/A	N/A	Spokane	Spokane	Yes	PCB use subject to TSCA Section 6 PCB inspection. No violations.	Yes	TSCA Section 6, 5/02/2000	No	None	No violations reported	N/A				N/A
U185	Lidgerwood Elementary	325 E. Rowan Avenue	EDR - FTTS	N/A	N/A	Spokane	Spokane	Yes	PCB use subject to TSCA Section 6 PCB inspection. No violations.	Yes	TSCA Section 6, 5/03/2000	No	None	No violations reported	N/A				N/A
U159	Louisiana Pacific Corp.	S. Spokane & 3rd Streets	EDR - FTTS	N/A	N/A	Post Falls	Kootenai	No	PCB use subject to TSCA Section 6 PCB inspection. Minor violation.	Yes	TSCA Section 6, 9/29/1988	No	None	Violation details not found	N/A				N/A

Site Details				Location					On-site PCB Use		Users					Discharges			
Map ID	Site Name	Address	Original List	WA Ecology Facility Site ID (FS ID)	WA Ecology Cleanup Site ID (CS ID)	City	County	Within Spokane City Limits?	Nature of PCB-related Operations	PCBs On-site?	Type?	Documented Spills?	Waste Manifest Information	PCB-related Violations	Notes	Discharge Type	Discharge Detail	Waterbody/ Sewershed	Additional Discharges
U141	Mcgraw Edison Svc.	N. 415 Fancher Road	EDR - FTTS	N/A	N/A	Spokane	Spokane	Yes	FTTS inspection (likely TSCA Section 6 PCB). Minor violation.	Yes	FTTS Inspection, 5/17/1985	No	None	Failure to report, label, mark, store, use, or inspect PCBs on-site	Fine: $3,825.00				N/A
U158	Mullan Road Elementary School	2616 E. 63rd Avenue	EDR - FTTS	N/A	N/A	Spokane	Spokane	Yes	PCB use subject to TSCA Section 6 PCB inspection. No violations.	Yes	TSCA Section 6, 3/14/2000	No	None	No violations reported	N/A				N/A
U151	Pacific Gas Transmission Co.	5105 E. Third Avenue	EDR - FTTS	N/A	N/A	Spokane	Spokane	Yes	PCB use subject to TSCA Section 6 PCB inspection. No violations.	Yes	TSCA Section 6, 8/03/1992	No	None	No violations reported	N/A				N/A
U163	Potlatch Corp Wood Products Western Div.	23rd & Sherman	EDR - FTTS	N/A	N/A	Coeur d'Alene	Kootenai	No	PCB use subject to TSCA Section 6 PCB inspection. No violations.	Yes	TSCA Section 6, 9/27/1988	No	None	No violations reported	N/A				N/A
U152	Pratt Elementary	6903 E. Fourth Avenue	EDR - FTTS	N/A	N/A	Spokane	Spokane	Yes	PCB use subject to TSCA Section 6 PCB inspection. No violations.	Yes	TSCA Section 6, 5/03/2000	No	None	No violations reported	N/A				N/A
U184	Ridgeview Elementary	1515 W. Joseph Avenue	EDR - FTTS	N/A	N/A	Spokane	Spokane	Yes	PCB use subject to TSCA Section 6 PCB inspection. No violations.	Yes	TSCA Section 6, 7/04/1999, 5/03/2000	No	None	No violations reported	N/A				N/A
U93	Oil Re-Refining Company (ORRCO)	11916 E. Empire Avenue	PCB National Report (2017)	N/A	N/A	Spokane	Spokane	Yes	Waste haulers and recyclers.	Yes	Storer	None	None	None	ORRCO is a used oil transporter/storer for the City of Spokane. They transport the used oil to a containment facility in Portland, OR.	Other	Outside of area		
U189	Rogers High School	1622 E. Wellesley Avenue	EDR - FTTS	N/A	N/A	Spokane	Spokane	Yes	PCB use subject to TSCA Section 6 PCB inspection. No violations.	Yes	TSCA Section 6, 3/16/2000, 5/01/2000	No	None	No violations reported	N/A				N/A
U145	Sacajawea Middle School	401 E. 33rd Avenue	EDR - FTTS	N/A	N/A	Spokane	Spokane	Yes	PCB use subject to TSCA Section 6 PCB inspection. No violations.	Yes	TSCA Section 6, 3/14/2000	No	None	No violations reported	N/A				N/A
U143	Sacred Heart Medical Center	W. 101 8th Avenue Taf C9	EDR - FTTS	N/A	N/A	Spokane	Spokane	Yes	PCB use subject to TSCA Section 6 PCB inspection. No violations.	Yes	TSCA Section 6, 5/26/1994	No	None	No violations reported	N/A				N/A
U187	Shadle Park High School	4327 N. Ash Street	EDR - FTTS	N/A	N/A	Spokane	Spokane	Yes	PCB use subject to TSCA Section 6 PCB inspection. No violations.	Yes	TSCA Section 6, 3/15/2000	No	None	No violations reported	N/A				N/A
U165	The Shampoo Co.	7320 Davenport Road	EDR - FTTS	N/A	N/A	Dalton Gardens	Kootenai	No	PCB use subject to TSCA Section 6 PCB inspection. No violations.	Yes	TSCA Section 6, 1/07/1998	No	None	No violations reported	N/A				N/A
U190	Shaw Middle School	4106 N. Cook Street	EDR - FTTS	N/A	N/A	Spokane	Spokane	Yes	PCB use subject to TSCA Section 6 PCB inspection. No violations.	Yes	TSCA Section 6, 3/16/2000, 5/01/2000	No	None	No violations reported	N/A				N/A
U167	Snow Peak Forest Products	3808 N. Sullivan Road, Bldg. 5	EDR - FTTS	N/A	N/A	Spokane	Spokane	Yes	PCB use subject to TSCA Section 6 PCB inspection. No violations.	Yes	TSCA Section 6, 5/25/2004	No	None	No violations reported	N/A				N/A
U142	Spokane School District Admin Office	200 N. Bernard Street	EDR - FTTS	N/A	N/A	Spokane	Spokane	Yes	PCB use subject to TSCA Section 6 PCB inspection. Minor violation.	Yes	TSCA Section 6, 3/16/2000, 5/01/2000	No	None	Failure to report	N/A				N/A
U138	Spokane School Plant Maintenance Facility	2815 E. Garland Avenue	EDR - FTTS	N/A	N/A	Spokane	Spokane	Yes	PCB use subject to TSCA Section 6 PCB inspection. No violations.	Yes	TSCA Section 6, 5/04/2000	No	None	No violations reported	N/A				N/A
U168	Spokane Steel Foundry Co.	N. 3808 Sullivan Road Spokane Ind. Pk., Bldg. 1	EDR - FTTS	N/A	N/A	Spokane	Spokane	Yes	PCB use subject to TSCA Section 6 PCB inspection. No violations.	Yes	TSCA Section 6, 4/3/1990, 2/28/1992	No	None	No violations reported	N/A				N/A

Site Details				Location					On-site PCB Use		Users					Discharges			
Map ID	Site Name	Address	Original List	WA Ecology Facility Site ID (FS ID)	WA Ecology Cleanup Site ID (CS ID)	City	County	Within Spokane City Limits?	Nature of PCB-related Operations	PCBs On-site?	Type?	Documented Spills?	Waste Manifest Information	PCB-related Violations	Notes	Discharge Type	Discharge Detail	Waterbody/ Sewershed	Additional Discharges
U155	Spur Industries	E. 17404 Euclid	EDR - FTTS	N/A	N/A	Spokane	Spokane	Yes	PCB use subject to TSCA Section 6 PCB inspection. No violations.	Yes	TSCA Section 6, 1/13/1986, 1/13/1987	No	None	No violations reported	N/A				N/A
U178	Travis Pattern & Foundry Inc.	1413 E. Hawthorne Road	EDR - FTTS	N/A	N/A	Spokane	Spokane	Yes	PCB use subject to TSCA Section 6 PCB inspection. No violations.	Yes	TSCA Section 6, 5/23/1990	No	None	No violations reported	N/A				N/A
U179	Westview Elementary	6104 N. Moore Street	EDR - FTTS	N/A	N/A	Spokane	Spokane	Yes	PCB use subject to TSCA Section 6 PCB inspection. No violations.	Yes	TSCA Section 6, 3/13/2000	No	None	No violations reported	N/A				N/A
U144	Wilson Elementary	911 W. 25th Avenue	EDR - FTTS	N/A	N/A	Spokane	Spokane	Yes	PCB use subject to TSCA Section 6 PCB inspection. No violations.	Yes	TSCA Section 6, 5/03/2000	No	None	No violations reported	N/A				N/A
U192	Power City Electric	202 E. Trent Street	Monsanto Invoices	N/A	N/A	Spokane	Spokane	Yes	Purchased PCB products. Transformer fluid Pyranol A13B3B-2.	Yes	Unknown, likely generator	None	None	None					
U193	ACME Machine Works	1220 N. Bradley Road	Monsanto Customer Records	N/A	N/A	Spokane Valley	Spokane	No	Purchased PCB products. Pydraul 312.	Yes	Unknown, likely generator	None	None	None	Purchase of Pydraul 312, a PCB-containing fluid.				
U194	Columbia Electric Supply	5818 E. Broadway Avenue	Monsanto Invoices	N/A	N/A	Spokane Valley	Spokane	No	Purchase of PCB products. Inerteen 100-42 fluid.	Yes	Unknown, likely generator	None	None	None	Purchase of PCB fluid Inerteen 100-42 billed to this location.				
U195	Sunset Transfer and Storage Inc.	216 West Pacific Avenue	Monsanto Invoices	N/A	N/A	Spokane	Spokane	Yes	Purchased PCB products. Pydraul A 200.	Yes	Unknown, likely generator	None	None	None	PCB transformer and PCB hydraulic fluid shipped to and from this site.				
U21	Roar Tech, Inc.	522 N. Fiske Street	PCB National Report (2009, 2017)	N/A	N/A	Spokane	Spokane	Yes	Waste haulers and recycler.	Yes	Generator	None	None	None	Roar Technologies removed a UST from the Spokane Coliseum for the City of Spokane in 1995.	Sewer	CSO	CSO 34 (Erie)	
U53	Shadle Center	2301 Wellesley Avenue	PCB National Report (2009, 2017)	N/A	N/A	Spokane	Spokane	Yes	Unconfirmed. Included on US EPA PADS list as a generator.	Yes	Generator	None	None	None	The facility is a mini-mall, gas station, and parking lot area. The facility is listed in the PCB National Report as a PCB generator, likely from industrial electrical equipment.	Sewer	CSO	CSO 06	
U20	Specialty Contractors, Inc.	2626 E. Trent Avenue	PCB National Report (2009, 2017)	N/A	N/A	Spokane	Spokane	Yes								Sewer	MS4	Union	
U22	Thermo Fluid, Inc. (TFI)	508 N. Fiske Street	PCB National Report (2009, 2017)	N/A	N/A	Spokane	Spokane	Yes	Waste haulers and recycler.	Yes	Transporter	None	None	None	TFI recycles used oil, stores chemicals in drums and generates dangerous waste per the City of Spokane.	Sewer	CSO	CSO 34 (Erie)	
U80	Trans-Tech, Inc.	2233 S. Garfield Road	PCB National Report (2009, 2017)	69825747	N/A	Airway Heights	Spokane	No	Waste haulers and recycler.	Yes	Smelter	None	None	None	The only facility in the area of interest listed as a smelter in the PCB National Report (2017). Little Information known about processes.	Other	Outside of area		
U128	United Engineering & Foundry Co.		Facility database of WWII-era facilities	N/A	N/A	Spokane	Spokane	Yes								Other	Outside of area		
U106	Vera Water and Power	601 N. Evergreen Road	PCB National Report (2017); LimnoTech PCB reduction report	47754249	9382	Spokane	Spokane	Yes	Utility. No PCBs known to be present at this location. Operate transformers throughout the watershed.	Not on-site. Transformers located throughout area.	Generator	None	None	None	Operates 137 transformers containing 2-43 ppm (average of 8 ppm).	Other	Outside of area		
U31	Atlas Systems	6416 E. Main Avenue	Monsanto Customer Records	N/A	N/A	Spokane Valley	Spokane	No											

Site Details				Location					On-site PCB Use		Users					Discharges			
Map ID	Site Name	Address	Original List	WA Ecology Facility Site ID (FS ID)	WA Ecology Cleanup Site ID (CS ID)	City	County	Within Spokane City Limits?	Nature of PCB-related Operations	PCBs On-site?	Type?	Documented Spills?	Waste Manifest Information	PCB-related Violations	Notes	Discharge Type	Discharge Detail	Waterbody/ Sewershed	Additional Discharges
U129	Washington Water Power Co.	1411 East Mission Avenue	PCB National Report (2009, 2017)	75513325	10412	Spokane	Spokane	Yes								Other	Injection and Infiltration (I&I)		
U219	Kootenai Electric Cooperative	2451 W. Dakota Avenue	LimnoTech PCB reduction report	N/A	N/A	Hayden	Kootenai	No	Utility. No PCBs known to be present at this location. Operate transformers throughout the watershed.	Not on-site. Transformers located throughout area.	Unknown likely generator	None	None	None	No additional information found.				

Notes:

CSO = Combined Sewer Overflow; ECHO = Enforcement and Compliance History Online; FTTS = Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA)/Toxic Substances Control Act (TSCA) Tracking System; HQ = Headquarters; MS4 = Municipal Separate Storm Sewer System; N/A = Not Available; NPDES = National Pollutant Discharge Elimination System; PADS = PCB Activity Database; PCB = Polychlorinated Biphenyl; ppm = Parts Per Million; RCRA = Resource Conservation and Recovery Act; TSCA = Toxic Substances Control Act; US EPA = United States Environmental Protection Agency; UST = Underground Storage Tank; WA Ecology = Washington State Department of Ecology.

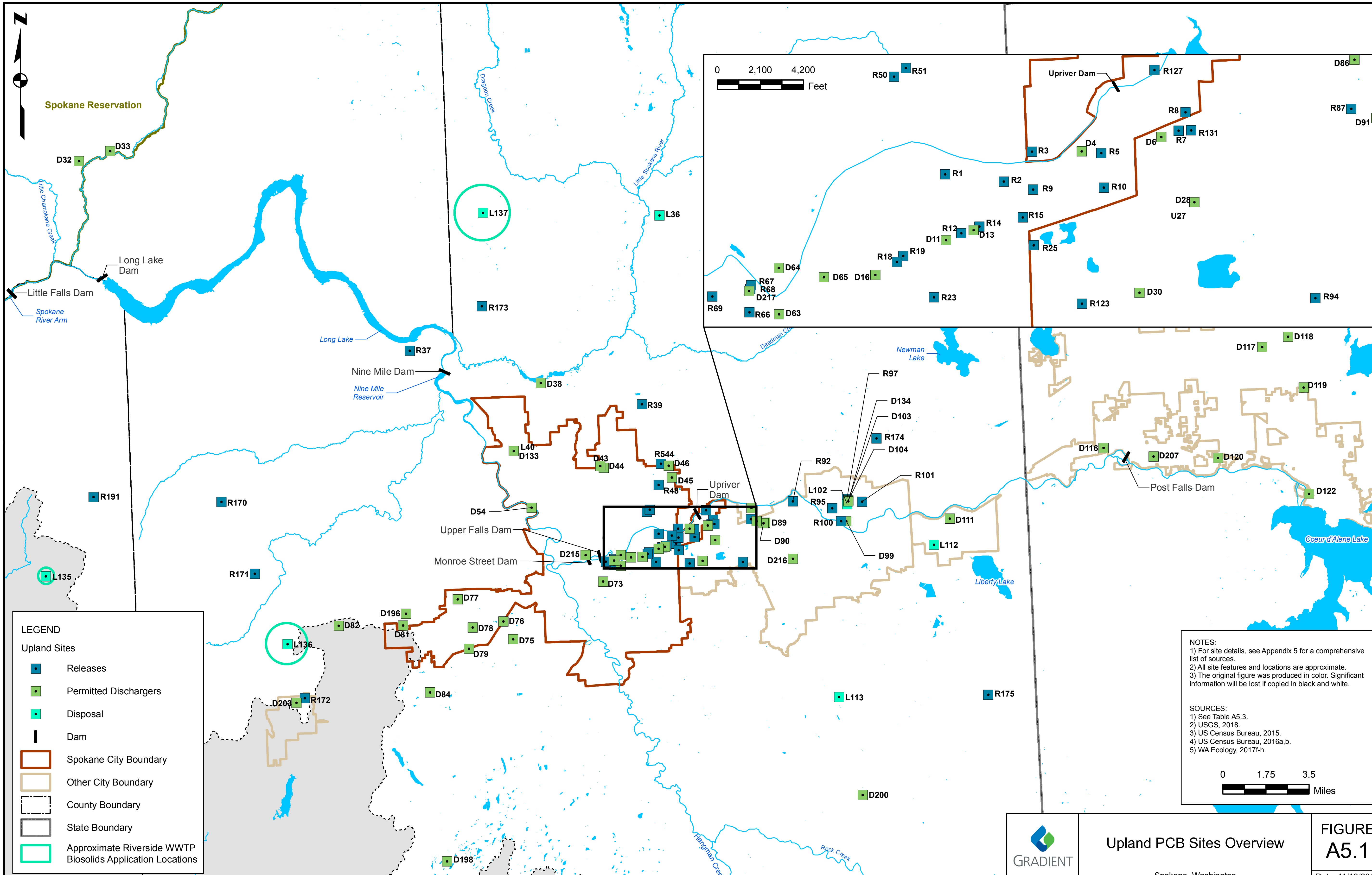
Table A5.3d Results of Upland PCB Site Research – Disposal

Site Details				Location					On-site PCB Use		Discharges		
Map ID	Site Name	Address	Information Source	WA Ecology Facility Site ID (FS ID)	WA Ecology Cleanup Site ID (CS ID)	City	County	Within Spokane City Limits?	Nature of PCB-related Operations	PCBs On-site?	Discharge Type	Discharge Detail	Waterbody/ Sewershed
L36	Colbert Landfill		Landfill	110	3035	Spokane	Spokane	No			Other	Outside of area	
L112	Greenacres Landfill		EDR; Landfill	631	1019			No			Other	Outside of area	
L113	Mica Landfill	T24N R44E S11, 14, MICA, WA 99211	Landfill; WA Ecology cleanup website details; Riverside WWTP SIU; SCRWRF SIU	633	1020	Mica	Spokane	No	Not confirmed. Known to receive sludge from Pentzer WWTP plant.	No	Other	Outside of area	
L40	Northside Landfill	W. 5502 Nine Mile Road	EDR; Landfill; WA Ecology cleanup website search	111	2500	Spokane	Spokane	Yes	No information re: PCBs has been identified. Operations started in 1931, closed in 1991. City of Spokane opened a new landfill at this site "recently" (as of 2002) that is still active. Old site added to the NPL in 1986 due to VOC impacts in groundwater.	Not confirmed	Other	Injection and Infiltration (I&I)	Infiltration area
L102	Old Inland Pit		Landfill	632	1181	Spokane	Spokane	No			Other	Outside of area	
L135	Near Reardan 2		Biosolid Disposal					No	Biosolid land application locations for Riverside WWTP.	No	Other	Outside of area	
L136	Near AFB		Biosolid Disposal					No	Biosolid land application locations for Riverside WWTP.	No	Other	Outside of area	
L137	Near Dear Park 2		Biosolid Disposal					No	Biosolid land application locations for Riverside WWTP.	No	Other	Outside of area	

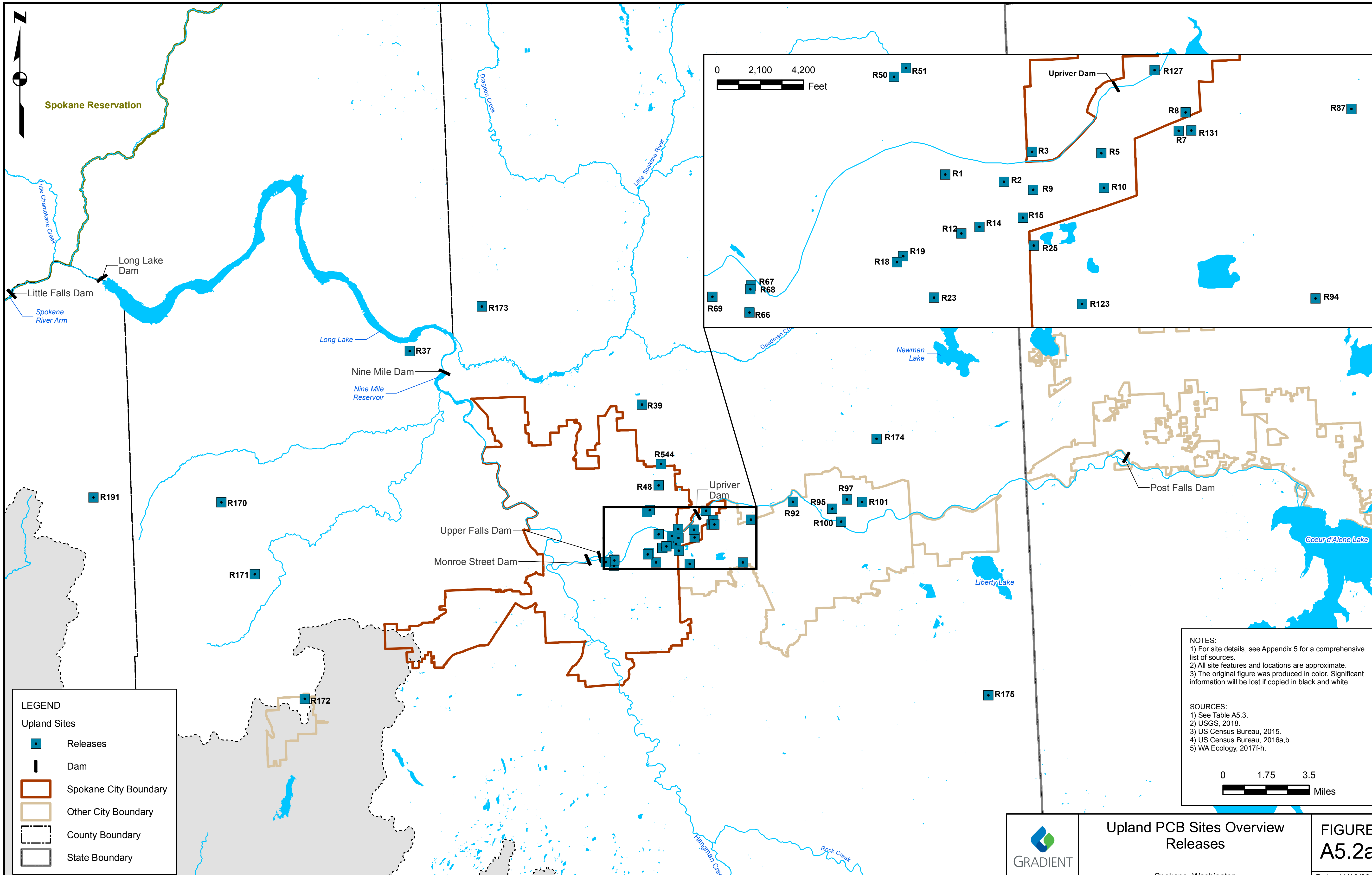
Notes:

AFB = Air Force Base; NPL = National Priorities List; PCB = Polychlorinated Biphenyl; Riverside WWTP = Riverside Park Water Reclamation Facility; SCRWRF = Spokane County Regional Water Reclamation Facility; SIU = Significant Industrial User; VOC = Volatile Organic Chemical; WA Ecology = Washington State Department of Ecology; WWTP = Wastewater Treatment Plant.

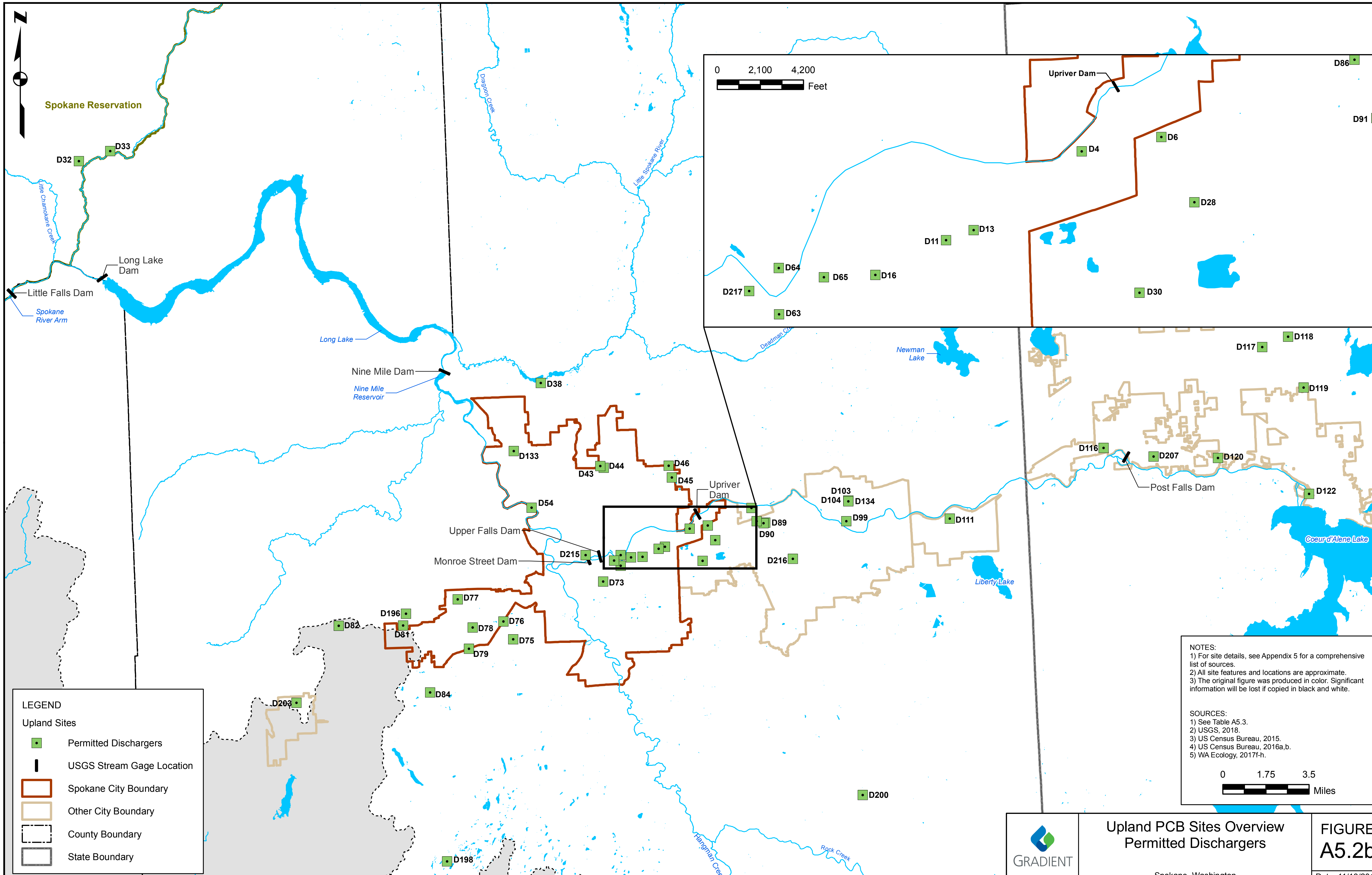
Figures

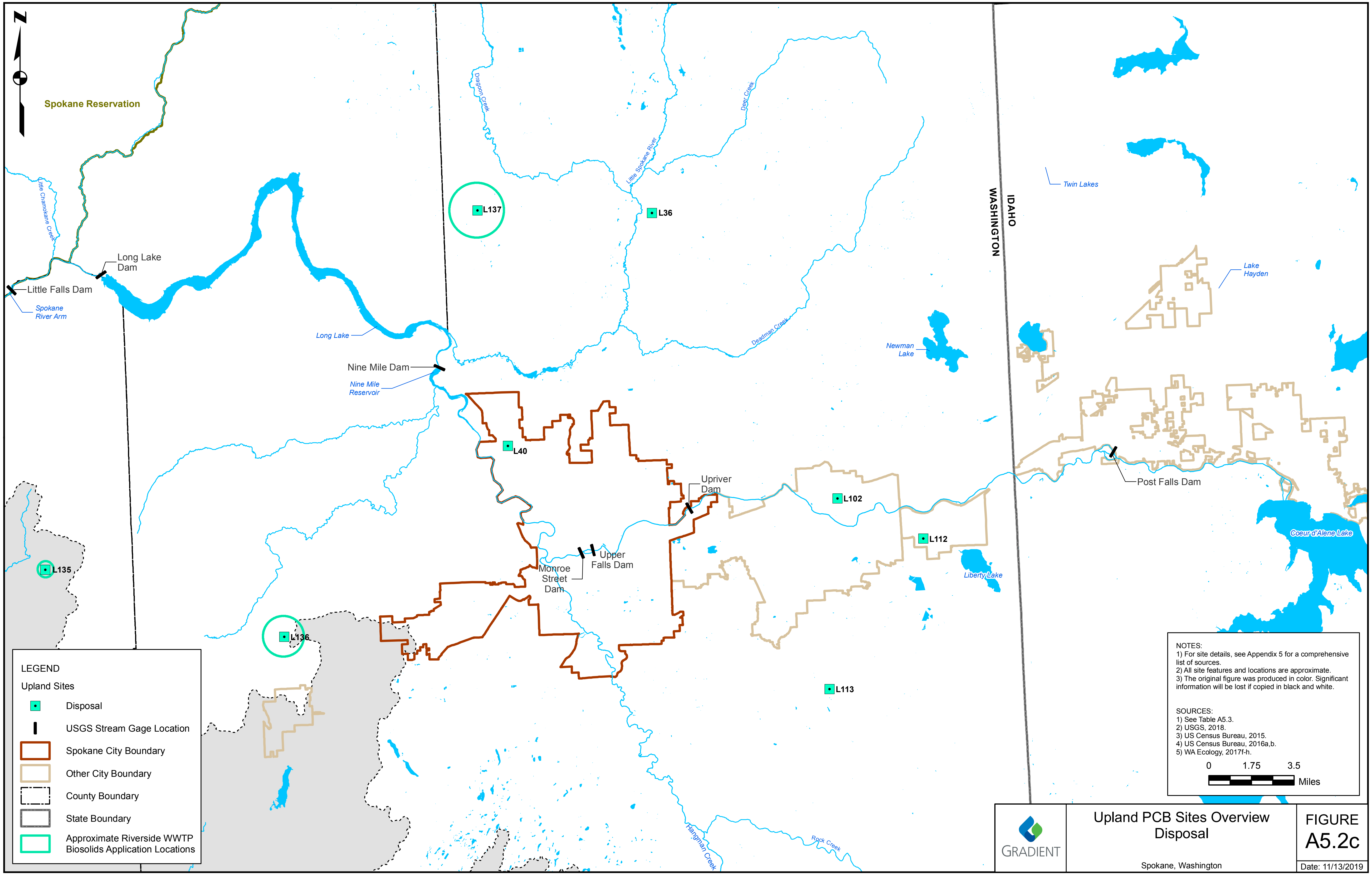


Spokane Reservation
Long Lake Dam
Little Falls Dam
Spokane River Arm
Long Lake
Nine Mile Dam
Nine Mile Reservoir
Upper Falls Dam
Monroe Street Dam
Upriver Dam
Post Falls Dam
Newman Lake
Liberty Lake
Coeur d'Alene Lake
0 2,100 4,200 Feet
LEGEND
Upland Sites
Releases
Permitted Dischargers
Disposal
Dam
Spokane City Boundary
Other City Boundary
County Boundary
State Boundary
Approximate Riverside WWTP Biosolids Application Locations
NOTES:
1) For site details, see Appendix 5 for a comprehensive list of sources.
2) All site features and locations are approximate.
3) The original figure was produced in color. Significant information will be lost if copied in black and white.
SOURCES:
1) See Table A5.3.
2) USGS, 2018.
3) US Census Bureau, 2015.
4) US Census Bureau, 2016a,b.
5) WA Ecology, 2017f-h.
0 1.75 3.5 Miles
GRADIENT
Upland PCB Sites Overview
Spokane, Washington
FIGURE A5.1
Date: 11/13/2019



Spokane Reservation
Long Lake Dam
Little Falls Dam
Spokane River Arm
Long Lake
Nine Mile Dam
Nine Mile Reservoir
Upper Falls Dam
Monroe Street Dam
Upriver Dam
Post Falls Dam
Newman Lake
Liberty Lake
Coeur d'Alene Lake
R173
R37
R39
R174
R544
R48
R191
R170
R171
R172
R92
R95
R97
R101
R100
R175
0 2,100 4,200 Feet
R50
R51
Upriver Dam
R127
R87
R8
R7
R131
R3
R5
R1
R2
R9
R10
R15
R12
R14
R25
R19
R18
R67
R68
R69
R66
R23
R123
R94
LEGEND
Upland Sites
Releases
Dam
Spokane City Boundary
Other City Boundary
County Boundary
State Boundary
NOTES:
1) For site details, see Appendix 5 for a comprehensive list of sources.
2) All site features and locations are approximate.
3) The original figure was produced in color. Significant information will be lost if copied in black and white.
SOURCES:
1) See Table A5.3.
2) USGS, 2018.
3) US Census Bureau, 2015.
4) US Census Bureau, 2016a,b.
5) WA Ecology, 2017f-h.
0 1.75 3.5 Miles
GRADIENT
Upland PCB Sites Overview
Releases
Spokane, Washington
FIGURE
A5.2a
Date: 11/13/2019


N
Spokane Reservation
D32
D33
Little Chamokane Creek
Long Lake Dam
Little Falls Dam
Spokane River Arm
Long Lake
Dragoon Creek
Little Spokane River
Deadman Creek
Nine Mile Dam
Nine Mile Reservoir
D38
D133
D43
D44
D46
D45
D54
Upriver Dam
Upper Falls Dam
Monroe Street Dam
D215
D73
D77
D196
D82
D81
D76
D78
D75
D79
D84
D203
D198
D103
D104
D134
D99
D89
D90
D216
D111
Newman Lake
Liberty Lake
D200
Hangman Creek
Rock Creek
D116
D207
D120
Post Falls Dam
D122
D117
D118
D119
Coeur d'Alene Lake
0 2,100 4,200
Feet
Upriver Dam
D86
D91
D6
D4
D28
D13
D11
D64
D65
D16
D217
D63
D30
LEGEND
Upland Sites
Permitted Dischargers
USGS Stream Gage Location
Spokane City Boundary
Other City Boundary
County Boundary
State Boundary
NOTES:
1) For site details, see Appendix 5 for a comprehensive list of sources.
2) All site features and locations are approximate.
3) The original figure was produced in color. Significant information will be lost if copied in black and white.
SOURCES:
1) See Table A5.3.
2) USGS, 2018.
3) US Census Bureau, 2015.
4) US Census Bureau, 2016a,b.
5) WA Ecology, 2017f-h.
0 1.75 3.5
Miles
GRADIENT
Upland PCB Sites Overview
Permitted Dischargers
Spokane, Washington
FIGURE
A5.2b
Date: 11/13/2019


N
Spokane Reservation
Little Chamokane Creek
Long Lake Dam
Little Falls Dam
Spokane River Arm
Long Lake
Nine Mile Dam
Nine Mile Reservoir
Dragoon Creek
Deer Creek
Little Spokane River
Deadman Creek
L137
L36
L40
L102
L112
L113
L135
L136
Upriver Dam
Upper Falls Dam
Monroe Street Dam
Newman Lake
Liberty Lake
Twin Lakes
Lake Hayden
Coeur d'Alene Lake
Post Falls Dam
WASHINGTON
IDAHO
Hangman Creek
Rock Creek
LEGEND
Upland Sites
Disposal
USGS Stream Gage Location
Spokane City Boundary
Other City Boundary
County Boundary
State Boundary
Approximate Riverside WWTP Biosolids Application Locations
NOTES:
1) For site details, see Appendix 5 for a comprehensive list of sources.
2) All site features and locations are approximate.
3) The original figure was produced in color. Significant information will be lost if copied in black and white.
SOURCES:
1) See Table A5.3.
2) USGS, 2018.
3) US Census Bureau, 2015.
4) US Census Bureau, 2016a,b.
5) WA Ecology, 2017f-h.
0 1.75 3.5 Miles
GRADIENT
Upland PCB Sites Overview
Disposal
Spokane, Washington
FIGURE
A5.2c
Date: 11/13/2019